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Suspension Shaper.

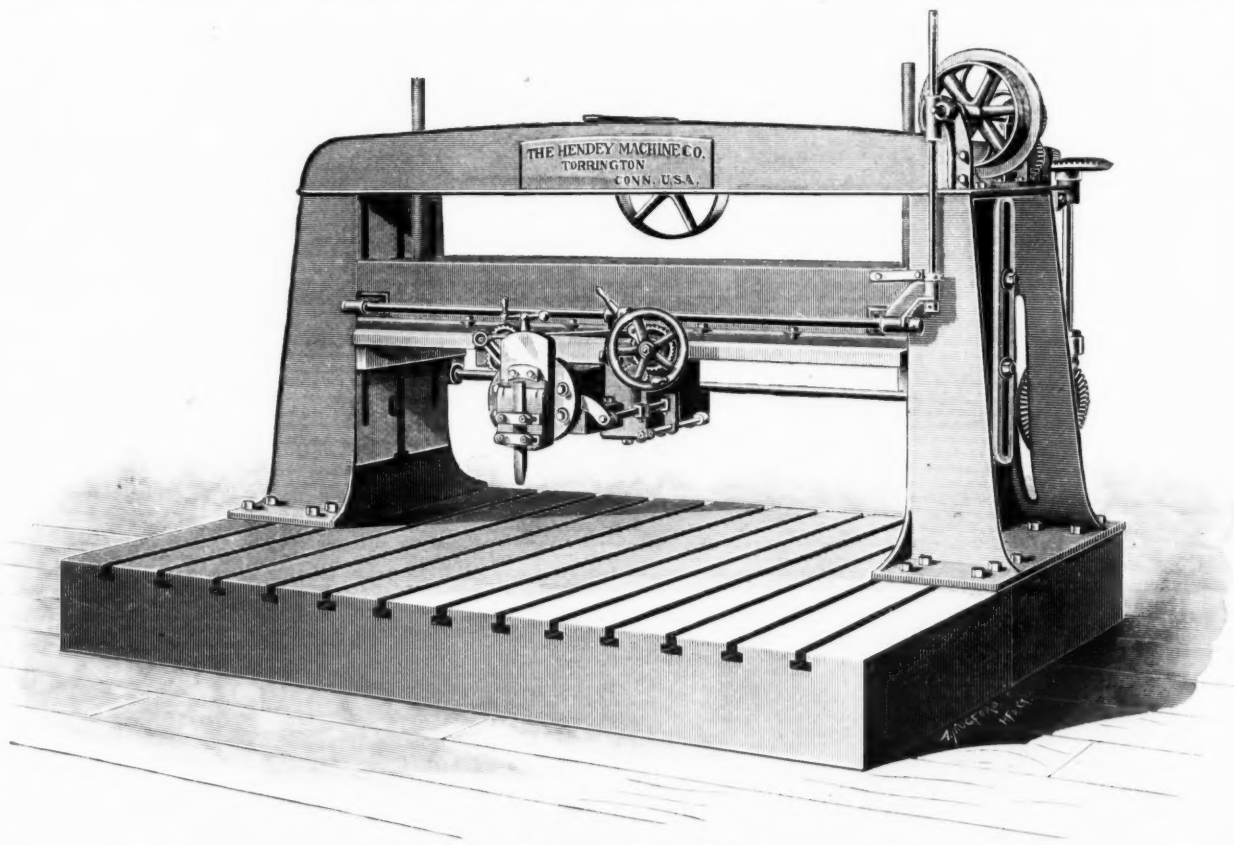
We present on this page an engraving of a form of shaper which has been designed to plane parts of castings or forgings of any required dimensions, even beyond the practicable limits of the planer. This is accomplished by arranging to fasten the work to a substantial bed plate which can be made any desired size, and is entirely open in two directions, so that the work operated upon is not limited in these directions except by shop room.

The tool-moving mechanism consists essentially of a shaper turned upside down, *i. e.*, the ram is supported and driven from above instead of from below, as usual.

The machine shown has a bed 10 feet long, by 7 feet wide, and 12 inches deep, and is to be set on a solid foundation.

The two housings or uprights, one on each end of the bed, carry the cross rail, which is fitted between them, and fastened by four screws on each end. The cross rail is raised and lowered by means of a screw at each end, by power, the same as the cross rail of a planer. The tops of the housings are connected together by the girder on top. Suspended on the cross rail, is the saddle. This in turn carries the ram with the head and tool for doing the work. The ram is driven from the pulleys on top of the girder, the power being transmitted through the vertical shaft, by means of bevel gearing, to the horizontal shaft shown.

On the horizontal shaft is a pinion running into a rack on the ram. The length of stroke is controlled by means of the dogs on the square bar shown at the right of the ram. The hand wheel in front is for moving the saddle along the cross rail. The rod across the front is the reversing rod to change the motion of the ram.



SUSPENSION SHAPER.

The machine has a stroke of 25 inches, and will take in 7 feet between the housings.

We are not informed as to the exact height of work taken by the machine illustrated, but the standards are, of course, made of any desired height, and, in fact, the machine can readily be made any desired size.

The machine shown weighs 25,000 pounds. It is built by The Hendey Machine Co., Torrington, Conn.

It is stated that Professor Langley, of the Smithsonian Institution, has perfected an instrument called a bolometer, in which a current of electricity is passed through a very fine wire. The resistance of the wire and constantly the strength of the current passing through it varies with the temperature, and by noting changes of current variations of temperature of the wire amounting to .000001 degree Centigrade (.00000047 F) are detected. With this instrument some hitherto unknown facts regarding the spectroscope have been discovered.

Steel for Safes.

BY W. F. DURFEE

Mr. Zen Brinus Lyon's communication (in yours of April 26th) *in re* "Manganese Steel for Safes," calls to mind some experience of my own with composite plates (alternate layers of iron and steel welded and rolled together) which were used for safe deposit vaults.

In 1872, while acting as superintendent of the Midvale Steel Works, I was consulted by the president of one of the leading banks in Philadelphia, relative to the material to be employed in the construction of some safe-deposit vaults which the bank had in contemplation. My advice was, "steel, hard steel, and *plenty of it*." "Oh! that will be very expensive," was the depreciative reply of the president; to which I answered that "the expense was an assurance of safety." "But (rejoined the president), here is a material (handing me a piece of a composite bar), that is much cheaper, and Jacques Palustris, who is the best mechanician in Philadelphia, has tried in vain, as you see (calling my attention to several drill marks penetrating the outer layer of iron, but showing that the drill had been stopped by the first layer of steel), to drill it." I replied that I was "well acquainted with Mr. Palustris, and fully agreed with the high estimate placed upon his skill, but nevertheless I would agree to drill the bar with steel made at the Midvale Steel Works."

He gave me the bar, and the next day I returned it, having two holes ¾ of an inch in diameter through it. The president was greatly astonished and annoyed. "How did you do it?" he asked. "With a common flat drill made of steel that we are selling for 16 cents per pound, and it required but 20 minutes to bore each hole." "What are we going to do! What are we going to do!" exclaimed the president. To which alarmful inquiry I responded, "You only can decide; but I will suggest that my original prescription, steel, hard steel, and *plenty of it*, is still available." I was politely assured that "the matter will have careful consideration," and that I would "probably hear from them again," but notwithstanding all my listening, I never did, directly, but in a few weeks after my last interview with the bank president, I learned, accidentally, that they had adopted the compound bar, because some of their neighbors were satisfied with it.

While such views of safety prevail with the managers of banking institutions, it is not surprising to men of experience with iron and steel, that,

> "The jolly, jolly burglar
> Keeps a-burglaring."

As a matter of fact, safety is never intimately associated with cheap construction in strong rooms, bank vaults and safe-deposit boxes. The best material is none too good, and even with that *mass* is an essential element of security.

I have no hesitation in saying that the majority of safes, vaults, and kindred structures now in use, can be opened without noise (by means which can readily be conveyed and used by two men) within two hours after commencing work. It may be urged that such effective methods of attack as have been alluded to are not within the knowledge of the ordinary burglar—suppose this be granted—it must also be admitted that there are a few extraordinary cracksmen; talent in that line of business, as in other occupations, has its gradations; there are bunglers and adepts in everything; and if the safety of our savings is to be assured, the skill of the adept in the art of burglary must be regarded in the strength of our coffers. No "manganese steel" or other alloy of metals now manufactured, is safe when used in moderate quantity against the silent and sure method of attack referred to, and it is not the part of wisdom to rely upon the supposed ignorance of the criminal classes for the safety of our treasures.

Thus far in this article we have been speaking solely with reference to the possibilities of what may be denominated the mechanical methods of operating against the metallic doors and walls of safes and vaults, and as difficult as it is to provide adequate protection against the highest skill of the art of mechanical burglary, it is still more difficult to insure protection against the giant chemical forces of the higher explosives. Without going into the details of the means of using such powerful forces, it must here suffice to say that it is not at all likely that the skill of man will invent any combination of materials suited to the uses of a safe or vault, that will be proof against their action. The chief protection which the community now has against their employment is the noise produced by their explosion. This brings us to the consideration of a possible means of protection which has hitherto not received that attention from mechanicians which its capabilities deserve; we refer to the automatic sounding of a prolonged alarm whenever the safe or vault is attacked by either mechanical or explosive means. I am well aware that this suggestion is far from being original; alarms have been applied to money drawers in recent years, and alarm locks have been known from very early times. The famous Marquis of Worcester (1663) in his "Century of Inventions" describes a lock which "if a stranger open it, it setteth an alarm agoing, which the stranger cannot stop from running out;" but this is not the first lock of the kind mentioned in history, for that which secured the doors of the wardrobe of Penelope antedated it over 2,600 years. Homer, as translated by Pope, gives the following description of the opening of her wardrobe by the wife of Ulysses:

> "A brazen key she held, the handle turned,
> With steel and polished ivory adorned.
> The bolt, obedient to the silken string,
> Forsakes the staple as she pulls the ring;
> The wards, respondent to the key, turn round,
> The bars fly back, the flying valves resound;
> Loud as a bull makes hill and valley ring,
> So roared the lock when it released the spring."

This was indeed an alarm of a most terrific and far-reaching character, doubtless well calculated to deter the primitive burglar. Applying the suggestions of this ancient alarm lock to modern conditions; if it was certain that any attempt to tamper with a safe or bank vault would result in putting in action some automatic apparatus, surpassing in power of bellowing the bulls of Bashan; or, possibly, liberate and make vocal some phonograph, plus fog horn, that would shout police! thieves! help! for an indefinite period; there is little doubt that most thieves would decline the risk liable to be created by such a mechanism.

Triple Expansion Steam Engines, Built by the Pupils of the Cincinnati Technical School.

In our issue of August 21, 1890, we published, with illustrations, a description of a slide-valve engine, built by the pupils of the Technical School of Cincinnati, the manual training high school of that city. Since that time three engines have been constructed in the school, to wit: One 5″x12″ slide valve, one 5″x8″x12″ tandem compound (now driving the machinery of the carpenter, blacksmith and machine shops), and one 4½″x7″x2—8″x12″ triple expansion engine, of which we publish drawings in this issue. The last one was exhibited at the World's Fair last summer, and is now in operation in the school shops. The designs for these three engines were prepared by J. B. Stanwood, director of the school, but all details and drawings were finally worked out and assembled in the general plan by the students. This work is similar to that of draftsmen in a drawing office under the direction of a chief. Theoretical questions are not extensively discussed, as the pupils who may become mechanical engineers will obtain theory enough and to spare in the higher technical schools of the country, and the others, the larger majority do not need it. This school aims to develop habits of industry and good judgment in the pupils, by giving them with regular high school studies concrete experience in the use of tools, and in methods of construction, forming a basis for a general or special education later on. The boy who may go to the higher institutions of engineering is far better equipped for his work if he has, besides the usual scholastic preparations, acquired the technique of drafting, and is also familiar with the properties of materials and machines, together with the methods of working and using them.

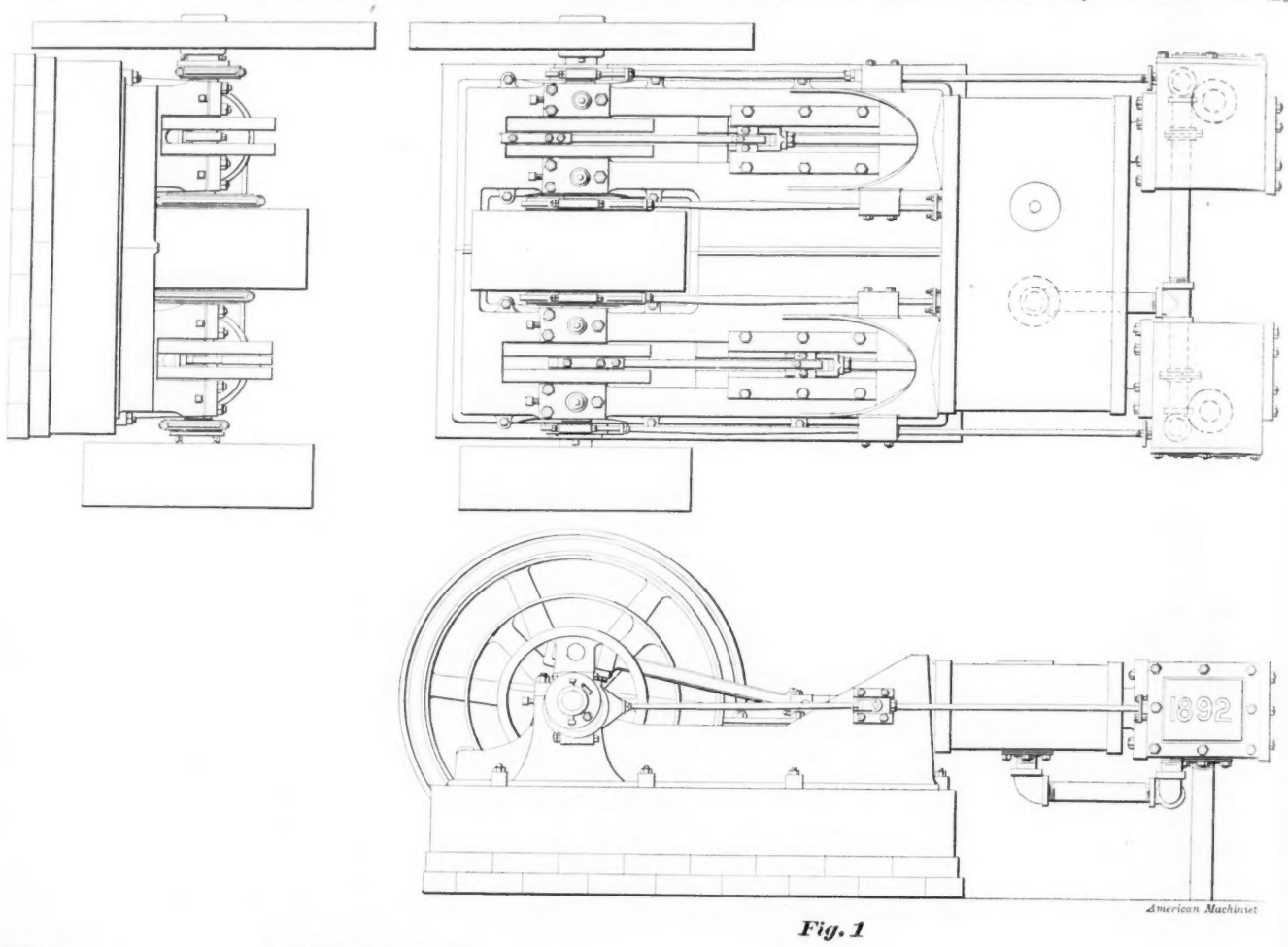


Fig. 1

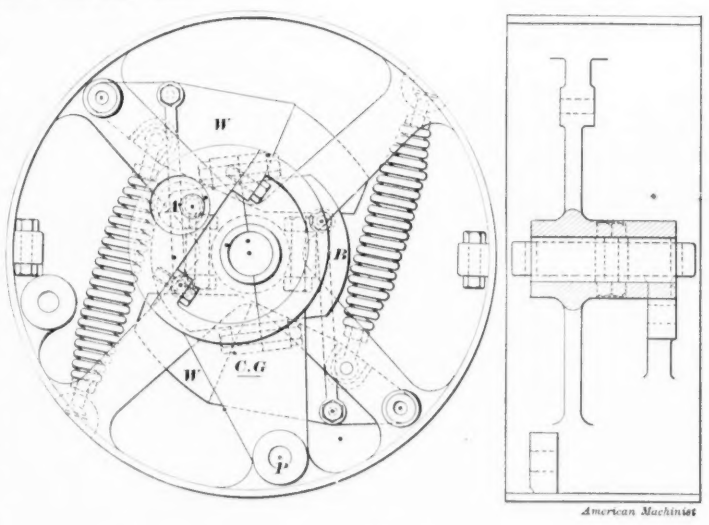


Fig. 2

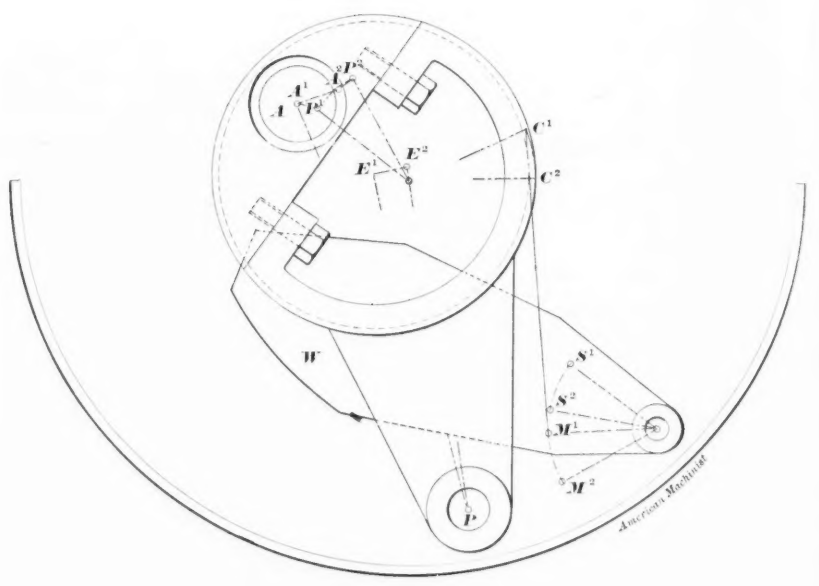


Fig. 3

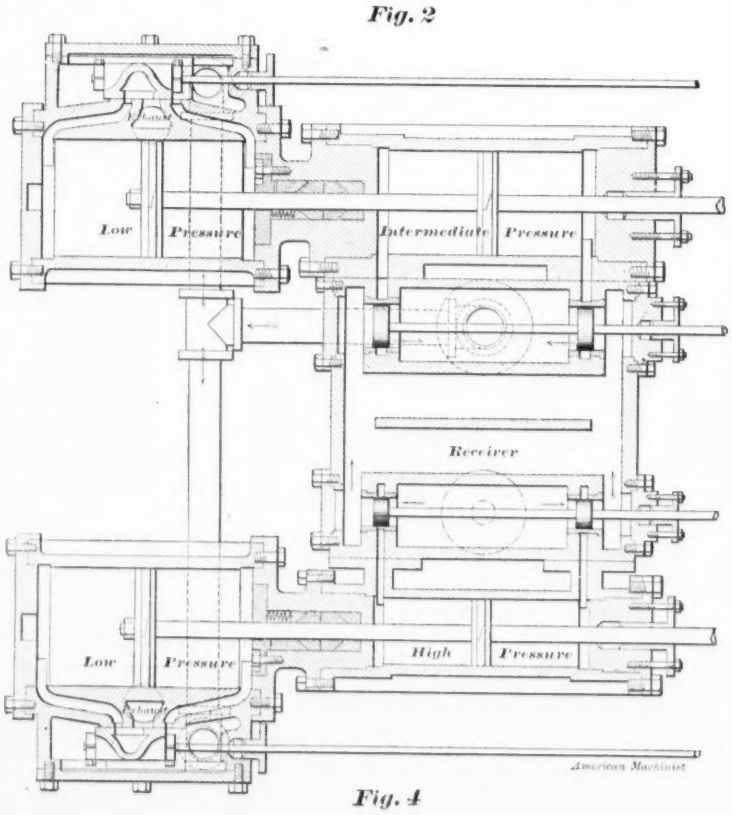


Fig. 4

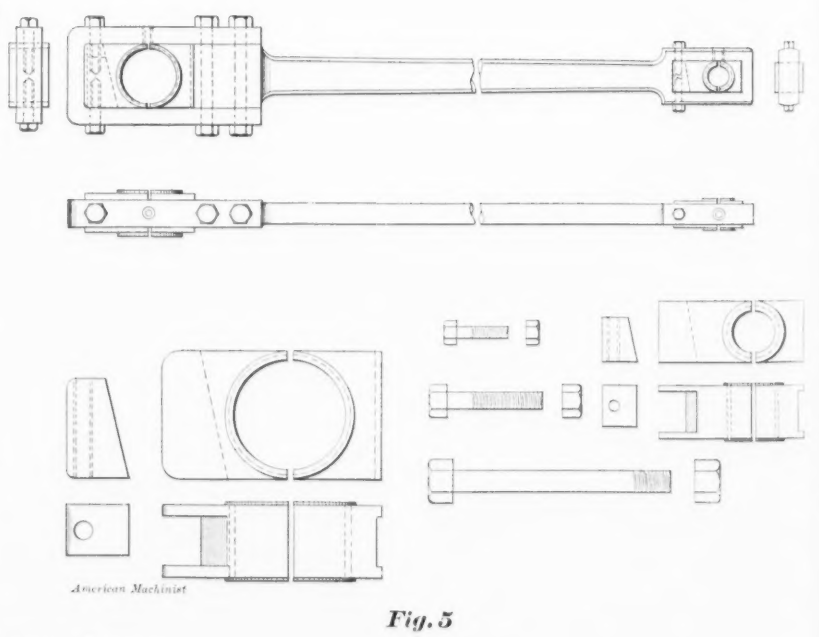


Fig. 5

TRIPLE EXPANSION ENGINES.

The original plan contemplated controlling the valves of both the high pressure and intermediate cylinders by one governor, in order to equalize the load between each pair of engines. The governor was at first constructed for this purpose, but the excessive compression and the high first receiver pressure produced when cutting off early with light loads led to the abandonment of this construction. The governor as it is now made, is shown by Fig. 2, and its motion sheet by Fig. 3. It consists of an eccentric swinging on pin *P*; this eccentric is also supported by a small eccentric *A*, which acts as a very short link, by which the main eccentric is moved across the shaft by the plate *B*, which is rotated by the action of the weights *W W* around the shaft.

The two low-pressure cylinders have simple slide valves, each operated by its own

eccentric. Each eccentric is attached to an expansion plate, by which its travel may be adjusted so that cut off and compression can be altered at will.

Fig. 4 is a cross section through the cylinders, showing valves, steam chest and connecting trunks. The packing used on the piston rods in the trunks is also shown. It consists of two taper brass sleeves, compressing a pair of split conical babbitted rings upon the rod, the entire nest being kept in position by three German silver springs.

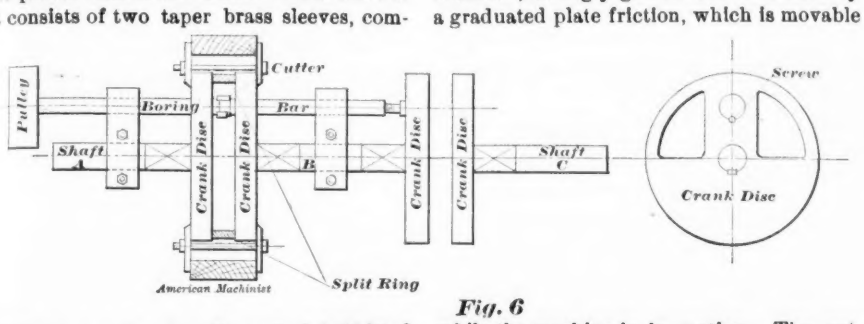


Fig. 6

Fig. 5 is a drawing of the connecting rod, which explains itself. The crosshead is of the same pattern used on the slide-valve engine previously illustrated.

The crank-shaft was built up on its bearings and constituted the closest work done on the engine. The bearings in the frame were first carefully babbitted, and scraped true to a straight mandrel. The three portions of the crank shaft *A*, *B*, and *C* (Fig. 6) were accurately turned and faced and placed in these bearings. Between the faces of the disks a perfectly parallel ring was clamped, as shown; this ring was in halves so that it could be removed after the crank pin was finally in position. Two disks were then clamped upon the ring, as shown, and a boring bar mounted on the shaft bored out the holes for the crank-pin. The pin, carefully fitted, was shrunk into its place, the holes being heated by hot irons placed in and around the disk. Finally the clamps and ring were removed and the second pair of disks treated in the same manner.

To prevent the crank-pins from jarring loose, a screw was inserted in the back of each, tapped half in crank disk and half in crank-pin.

The engine without wheels weighs two tons. As yet it has no condenser, so the low-pressure cylinders give but little satisfaction. Next year the condenser will be built by the pupils to make the engine complete.

Band Re-sawing Machine.

We illustrate herewith a band re sawing machine, which is stated by its makers to be the best machine of its class they know how to make, and it certainly possesses many points of peculiar excellence.

It is capable of re-sawing large timbers, as well as converting lumber into panels, picture backing, box material, etc., in the most rapid and perfect manner, and is made to saw straight or beveling.

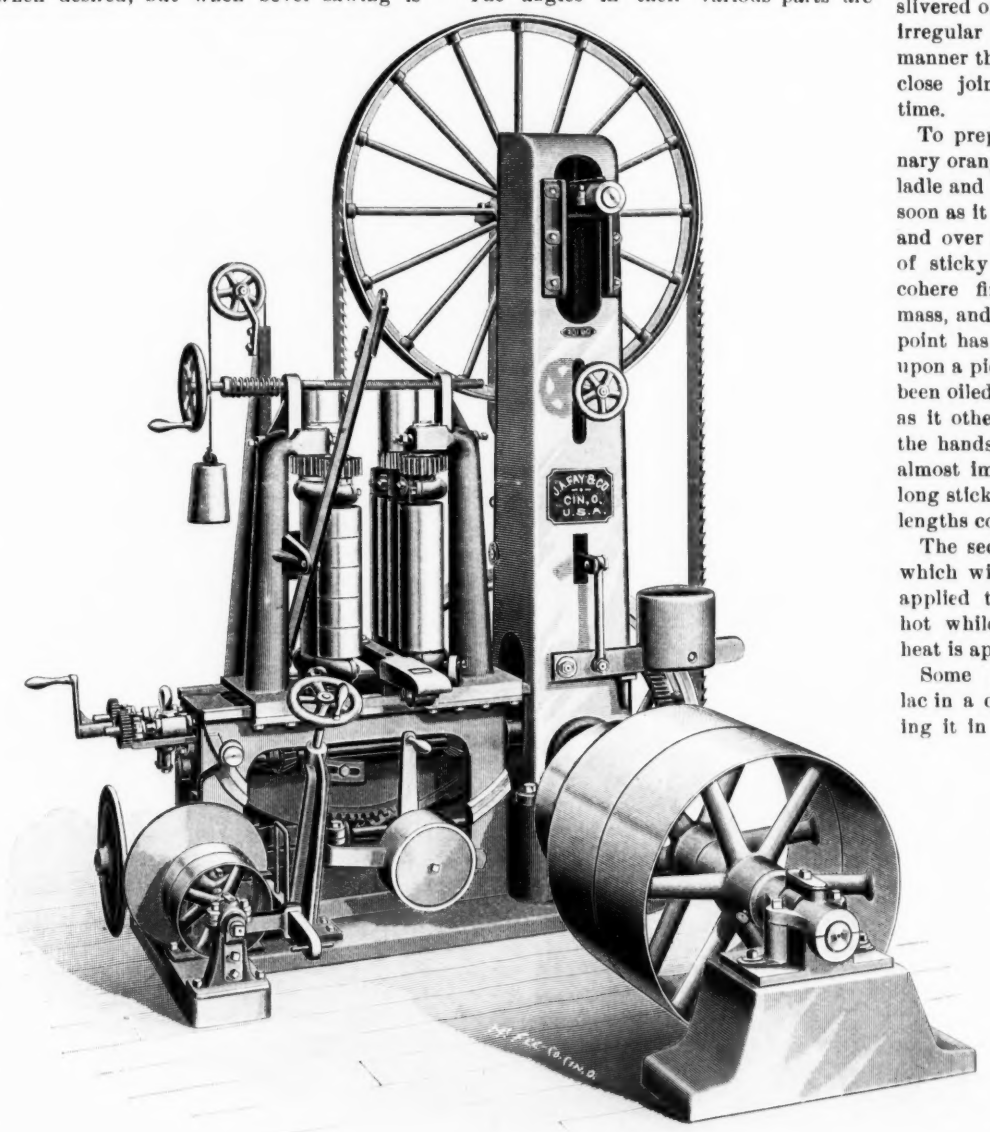
The machine will re saw material 30 inches wide and 13 inches in thickness; will re-saw to the center of 10 inches, and will saw from the side of a timber 8 inches thick. The saw kerf removed is very slight, as saws of the thinnest possible gauge may be used with perfect safety—saws down to 24 or 25 B. & S. gauge, and in the hands of a skilled operator these thin blades give entire satisfaction, though for rapid work, about 20 or 21-gauge saws are best.

Short pieces of material may be re-sawed owing to the position of the rolls with relation to the blade.

The wheels are made entirely of iron, 50 inches in diameter, and 5 inches width of face, supported on shafts $2\frac{1}{2}$ inches in diameter, with three long self lubricating bearings, there being an outside bearing supporting each wheel on each side of the column. The lower wheel is much heavier than the upper one, preventing trouble by a possible sudden checking of its speed unaccompanied by a corresponding check in the motion of the upper wheel.

The saw is strained by an improved method, overcoming any tendency to vibration in its movements. The makers usually furnish a 5-inch blade, but narrow blades may be used when desired.

The feed is exceedingly powerful, consisting of six large feed-rolls 5 inches in diameter, strongly geared and controlled by a graduated plate friction, which is movable while the machine is in motion. The outside rolls are made sectional to enable the operator to feed two or more narrow boards of unequal thickness at the same time by placing them one above the other. The sections yield independently or together. The rolls, with their supporting frame, are arranged to tip to an angle of 15 degrees, when desired, but when bevel sawing is not required, they are made stationary, at a reduction in cost. The feed is from 0 to 100 feet per minute.



BAND RE SAWING MACHINE.

The upper guide is controlled by a lever, and instantly adjusted to any desired height above the platen, and held in position by a counterbalance. The makers furnish with the machine one saw blade, full set of wrenches, blue print to aid in setting up, etc. Weight of the machine is 6,600 pounds.

It is built by J. A. Fay & Co., Cincinnati, Ohio.

Money Value of Hands and Fingers.

According to a scale drawn up for the Miners' Union and Miners' Accident Insurance Companies of Germany, the loss of both hands is valued at 100 per cent, or the whole ability to earn a living. Losing the right hand depreciates the value of an individual as a worker 70 to 80 per cent., while the loss of the left hand represents from 60 to 70 per cent. of the earnings of both hands. The thumb is reckoned to be worth from 20 to 30 per cent. of the earnings. The first finger of the right hand is valued at from 14 to 18 per cent., that of the left hand at from 8 to 13.5 per cent. The middle finger is worth from 10 to 16 per cent. The third finger is valued at no more than 7 to 9 per cent. The little finger is worth 9 to 12 per cent The difference in the percentages is occasioned by the difference in the trade, the first finger being, for instance, more valuable to a writer than to a digger.—*British Medical Journal.*

Pattern Room Odds and Ends.

BY JOHN M. RICHARDSON.

TO REMOVE SHELLAC FROM OLD PATTERN LETTERS.

When letters are removed from old patterns for one cause or another and are not mutilated, there is no necessity for throwing them away.

The angles in their various parts are badly filled, owing to many successive coats of shellac, but they can be easily and quickly cleaned so as to look almost like new.

There are two ways of accomplishing this, which are about equally good. One is to take all the letters, place them in a small tin dish of some sort containing aqua ammonia, and then boil, stirring briskly with a stick meanwhile until quite clean.

The other method is precisely the same, except to use a strong solution of sal soda and water instead of the aqua ammonia.

TO REMOVE A FACE PLATE FROM THE LATHE WHEN STUCK FAST.

This state of affairs occurs occasionally through a little carelessness, and causes much annoyance. If it resists ordinary treatment the following will be found a specific for the complaint:

Take a large hand clamp, and grasp the largest step of the cone pulley on the headstock firmly, so that it will be impossible for it to stir, having the butt end of the clamp resting on the lathe bed. Put two large screws through holes in the face-plate opposite each other, and as far apart as possible. Next get a small stick of timber strong enough not to break, perhaps eight feet or more in length, and clamp one end firmly against the face-plate, between the two screws just mentioned, which simply act as a fulcrum for the lever and are not screwed into the stick, which simply rests over one and under the other. Grasp the farther end of the lever thus rigged and give a strong firm pull. This will loosen a face-plate from the shoulder on a lathe spindle every time. In a very bad case it is a good plan for one person to tap the shoulder on the face-plate lightly with a hammer while another pulls at the lever, but this is seldom necessary.

TO MAKE HARD SHELLAC IN STICK FORM.

Hard shellac very many times affords the patternmaker a substitute for beeswax and putty, and is much superior to either in certain places, as on exposed corners where a pattern has been bruised, or a small piece slivered off; likewise on small work, where irregular surfaces come together in such a manner that it is very difficult to arrive at a close joint without spending unnecessary time.

To prepare this take some flakes of ordinary orange shellac, place a quantity in a ladle and hold over a forge or gas flame. As soon as it begins to melt roll the mass over and over with a stick until it forms a sort of sticky ball or wad, where the flakes all cohere firmly together in a soft, doughy mass, and yet is not a liquid. When this point has been reached empty the contents upon a piece of board which has previously been oiled to prevent its sticking as badly as it otherwise would, and just as soon as the hands can be borne upon it, which is almost immediately, pull out quickly into long sticks like candy, and cut into short lengths convenient for use.

The secret of making good stick shellac which will melt easily and work well when applied to patterns, is not to heat it too hot while in the ladle, for if too much heat is applied the contents will be ruined.

Some prefer to place the flake shellac in a cloth and boil in hot water, melting it in that manner. This is a somewhat quicker way, but having seen both methods tried I prefer the first, mainly for the reason that there is no moisture imprisoned within the sticks to sputter when applied to the flame while being melted over the work.

TO CURE A SQUEAKING BELT.

I had been troubled for many months with this nuisance on a belt from the main shaft to a countershaft driving a buzz planer, and the piercing shrieks which it sometimes gave were enough to make one's blood run cold.

How to remedy this difficulty was a question I made little headway in solving, for any one of the various substances which were applied gave only a very temporary relief. I can now recommend the following:

First clean the tight pulley on the countershaft carefully with alcohol or turpentine, then cut a number of strips of thick brown wrapping paper the same width as the face of the pulley, and give both the pulley and strips several coats of thick shellac, one after the other, and while they are all in a sticky condition take a strip and wind it firmly around the pulley, and so on, till a few thicknesses have been applied, then wind tightly with a string and let stand to dry.

The belt should be tightened if loose, so that it will have the proper tension on the loose pulley, and then when the paper is dry and hard, the string removed, and the machine started, the belt rides easily over

on to the tight pulley which is somewhat larger in diameter, owing to the thicknesses of paper, and thus any slipping is prevented and consequently the squeak.

TO APPLY LEATHER FILLETS.

Without wishing to start any controversy as to the relative merits of wood, beeswax, putty, lead and leather for fillets, all of which may have their time and place, my preference is leather for corners of small radius on good patterns for the following reasons:

It strengthens a joint wonderfully, especially on frail work, and holds the parts so securely that wire nails are in many cases unnecessary.

It can be applied with great facility by a person who is familiar with its use.

It does not dent easily, will never peel up when properly put on, and requires no nailing.

To apply neatly, four things are necessary, quite thick glue, hot water, a flannel rag and a "slicker," sometimes called a corner iron; in fact, anything that would lay a wax corner of equal size successfully will answer.

First apply the glue to the fillet by laying it on a piece of board and drawing the brush across its back, or else draw the leather along over the edges of the glue pot and apply the glue as it moves along.

Next lay the leather corner in its proper place on the pattern, and instantly draw a wet flannel rag, as hot as the hand can bear, along on top of the leather. This wipes away the superfluous glue, and the heat seems to cause the glue underneath to set quickly; follow with the slicker, bearing down quite hard, this squeezes a little more glue from the joint which must in turn be wiped with the hot rag.

The moisture of the cloth will not injure the pattern in the least, if squeezed by the hand so that the excess of water is removed, and the wood dries surprisingly quick, especially if the corner is finally gone over with a dry cloth.

The office of the wet rag is to effectually wipe off every particle of exposed glue, so that the sand cannot possibly adhere to the joint.

HARDWOOD FACE PLATES.

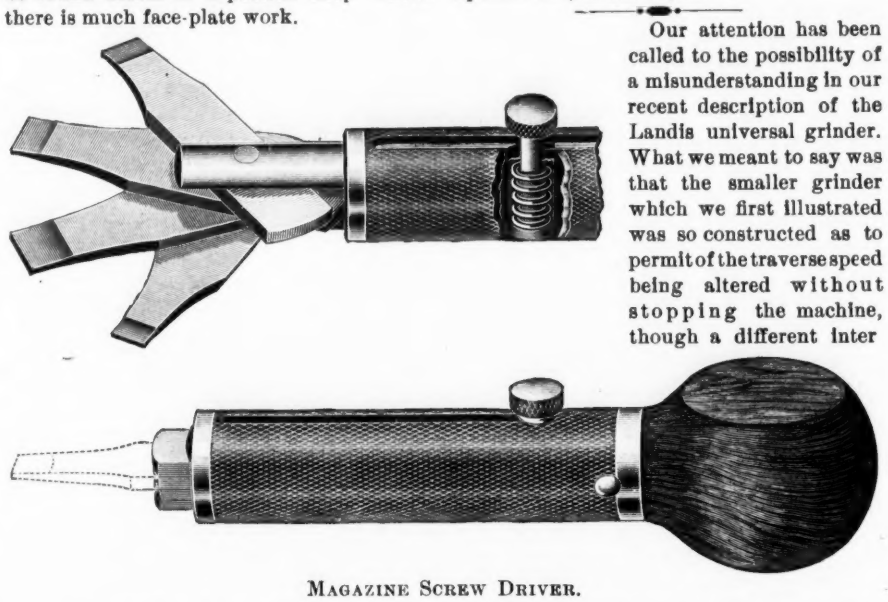
But one face-plate chuck is usually furnished with a patternmaker's lathe, besides the one that goes on the outside spindle for large work, and the screw chuck for light turning.

It often happens on jobs of segment work that two face-plates, and occasionally more, can be used to much better advantage, because by the time a layer is glued on the first, it can be set aside and a layer put on the second, and by that time, if the glue is quick-setting, the first can be taken up and faced off. Thus a man can put his time continuously upon the work without seeking other jobs during the waiting periods, which is advantageous, for it is a hard thing for most men to put their mind first on one thing and then another for short alternating periods.

I have found wooden face-plates to answer admirably, and wear well, giving no trouble whatever, and running very true indeed.

Take a piece of well-seasoned hardwood, band saw it to about the diameter desired, and have it of a thickness somewhat in excesss of the lathe spindle outside the shoulder. Bore a hole with an extension bit having a diameter equal to the roots of the thread, and have it placed in an engine lathe and a thread cut in it precisely as though it was iron. Next screw it on the spindle of the pattern lathe as far as it will go, which will be not quite to the shoulder for the thread starts a short distance away. Now face off its surface, and turn the thread off entirely for a short distance. This is in order that the piece can be screwed back tightly against the shoulder when reversed. Nothing remains but to true up the diameter and front surface. The work can be attached directly to the face-plate just described, but it is better to bore four holes for screws, and fasten on a piece of pine, using it precisely as though it was made of iron.

As many of these as seems desirable can be made at a slight expense, and will always be found useful in a pattern shop where there is much face-plate work.



MAGAZINE SCREW DRIVER.

Magazine Screw Driver.

We present herewith full size engravings of a new combination screw driver, which is especially adapted to the requirements of sportsmen or of mechanics so situated as to be liable to need various sizes of screw drivers, and are yet limited for room to carry tools or must carry them in their pockets.

Four sizes of screw drivers are contained within the handle, and are pivoted within a sliding piece which is locked in place by the small locking bolt seen at the side.

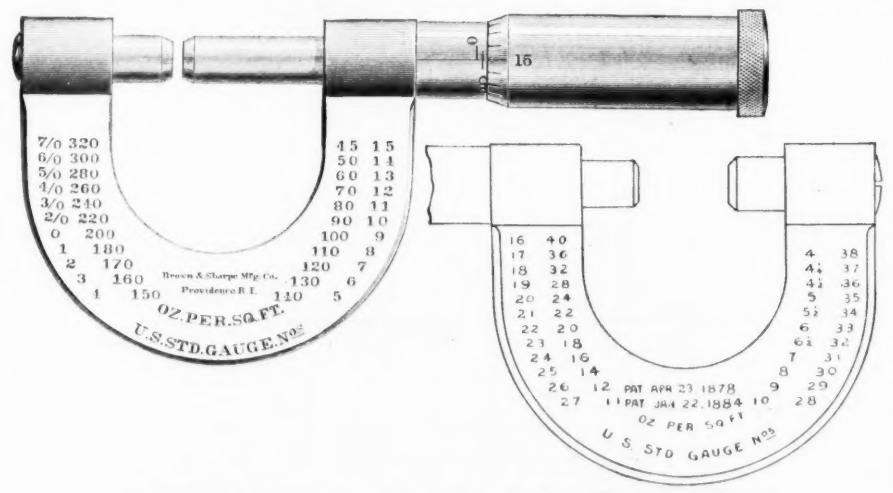
By raising the locking bolt and pressing forward the slide to end of slot, the screw driver blades will swing out. Select the size driver wanted and draw the slide back into the handle and driver is ready for use. The total length when closed is 3⅝ inches.

It is manufactured by The Billings & Spencer Co., Hartford, Conn.

Our attention has been called to the possibility of a misunderstanding in our recent description of the Landis universal grinder. What we meant to say was that the smaller grinder which we first illustrated was so constructed as to permit of the traverse speed being altered without stopping the machine, though a different interpretation of our language might be possible.

Micrometer Caliper for Sheet and Plate Iron and Steel.

We present herewith an illustration showing a special adaptation of the familiar micrometer caliper, an adaptation which ought to do much towards the ultimate solution of the vexed question of a sheet-metal gauge.



MICROMETER CALIPER FOR SHEET AND PLATE IRON AND STEEL.

The caliper, as will be seen, is constructed in the usual form, and has a capacity to measure up to 0000000 (7–0) or nearly ½ inch. But instead of being graduated in the usual manner, *i. e.*, to read fortieths of an inch on the barrel and thousandths of an inch on the thimble, each graduation on the barrel indicates 20 ounces per square foot of the iron or steel of corresponding thickness, while each graduation on the thimble indicates one ounce weight per square foot. For instance, the caliper set as shown in the illustration, would read, 35 ounces per square foot, instead of .04 inch, as the machinist's caliper would when correspondingly set.

It will be noticed that there are two sets of figures upon the bow; one of these being ounces per square foot; while the other is gauge numbers, these being so arranged that equivalent weights and gauge numbers adjoin each other, and thus equivalents are easily read.

The value of the graduations and the tables used are based upon the gauge adopted by the U. S. Congress, approved March 3, 1893; the screw has 32 threads per inch, and there are 20 divisions on the beveled edge of the thimble.

The caliper possesses all the refinements and facilities for adjustment possessed by other B. & S. micrometer calipers, and is manufactured by Brown & Sharpe Manufacturing Co., Providence, R. I.

An Improved Valve.

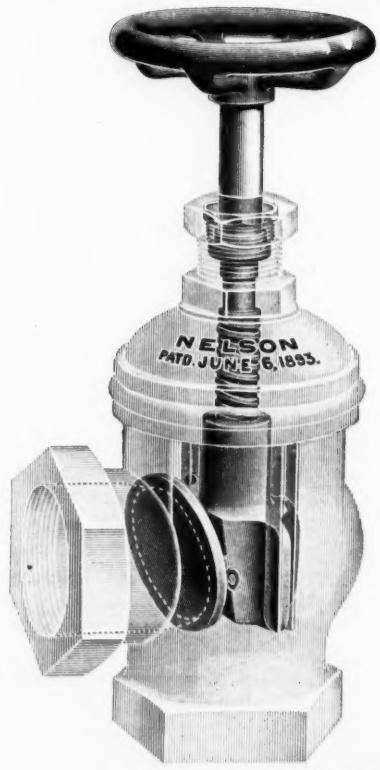
We illustrate herewith an angle valve which, as will be seen, possesses some features of novelty, especially in the arrangement of the disk, which rests upon the seat when the valve is closed.

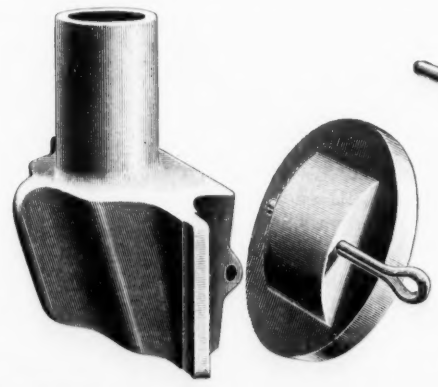
The engraving shows the valve as though the outer shell was transparent, and, as will be perceived, the stem is a "stationary" one, its thread being inside, and fitting a tapped hole in the gate or wedge, which is thus drawn from or forced to its seat.

The disk is made of unalloyed copper, and is hinged to the wedge in such a manner (as shown) that it must in every case come fairly down upon the seat. By this construction, not only is a tight valve obtained, but the disk is very easily renewed by simply pulling out the small pin which holds it in place. This pin, it will be understood, bears none of the strain incident to forcing the disk to its seat, the bearing for this being upon the solid metal of the rounded surfaces at the back of the disk.

There is also an improved stuffing-box for the stem of this valve. A collar is turned on the spindle, which is ⅛ inch smaller than the thrust collar, and the thrust nut is counterbored, making a compact and locked stuffing-box, from which the packing cannot get out. In addition to this is the regular stuffing-box at top, which is in the usual form, the two making a packing arrangement which is very superior.

When straightway valves are made on this system, there are two seats opposite each other, with a disk for each one swiveling upon a horizontal pin, the other upon a vertical one, thus practically insuring that at least one of them shall always be tight even where some solid substance prevents the seating of one disk. These valves are made in various styles and sizes by the Pacific Tucking and Manufacturing Co., 471–473 Eighteenth street, Brooklyn, N. Y.

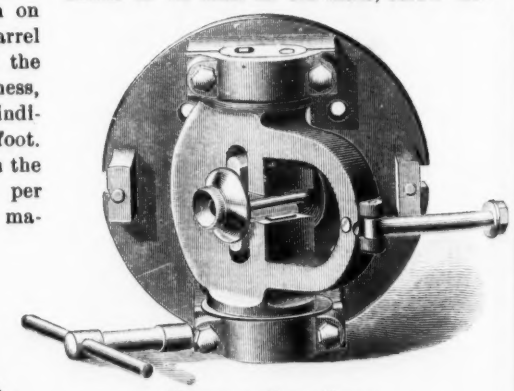




AN IMPROVED VALVE.

Reverse End Chuck.

The accompanying illustration is of a chuck to be used on the lathe, screw machine or similar tool, and is designed for holding bicycle hubs or other similar work where it is desired to finish both ends or sides without resetting or removing the work from the jaws of the chuck.



REVERSE END CHUCK.

The chuck proper is a solid steel yoke, or head, having a jorunal at each side on which it rotates in bearings on the main frame, or body, permitting the head and work to be completely reversed.

The head is fitted with a pair of steel jaws, having removable faces, which are bored to suit the work after the chuck is fitted to the lathe.

The jaws are brought together simultaneously by a right and left screw, oper-

ated from either end, thus centering the work.

On one side of the yoke is fitted a hinged bolt for securely clamping the head in either position. Hardened steel seats are also inserted in the yoke and main body to insure the accurate alignment of the work.

The main body is fitted to a face plate on the spindle of the lathe or screw machine in the usual way.

The manufacturers are The Garvin Machine Co., Laight and Canal streets, New York.

Surface Grinder.

In a previous issue we described a universal grinding machine as built by The Appleton Mfg. Co., Philadelphia. Our present illustration represents an arrangement for surface grinding which has recently been added to the machine.

Fig. 1 shows the machine set for work held between the centers. For surfacing, the wheel-head, head-stock and foot stock are removed, and in their stead is substituted a head carrying the surfacing feature, Fig. 2, which is provided with vertical and across-table adjustments.

The emery wheel, which is driven by an idler on the countershaft, may be either a regular or cup wheel, the latter being used for grinding the ends of long pieces and irregular shapes otherwise difficult to finish as economically.

The platen may be operated either by hand or automatically and has a longitudinal motion of 18 inches. The surfacing head has a movement across table of 4 inches which gives the machine a capacity for grinding pieces 18 inches long, 4 inches wide, and of a height depending upon the diameter of emery wheel, the center of spindle being 8 inches above the platen.

LETTERS FROM PRACTICAL MEN.

"Personnel of the Navy"—The "Alabama."

Editor American Machinist:

In your issue of May 10th I notice that Mr. Harrison, in his reply to Mr. Guthrie, cites the case of the "Alabama" and "Kearsarge," ascribing the superior steaming qualities of the latter to the greater latitude allowed the men. I have nothing to say on the merits of the question at issue, but wish to point out the fact that the "Alabama" was built for a fast sailing vessel, and proved herself such. Her engines were merely auxiliary, and very small affairs at that. I was working at Laird's at the time she was built, and remember being struck with the unusual proportions of the engines. They were horizontal, with cylinders 24 inches diameter, and, I believe, not more than 18 inches stroke, with direct connections, which necessitated a short stroke to accommodate the narrow proportions of the vessel. Under sail, the "Alabama" made fifteen knots, while under steam she was simply nowhere. Very likely, as Mr. Harrison points out, that part of the outfit was not as well looked after at sea as the more important sailing qualities.

Perhaps it would be interesting to your readers to learn of an incident which happened during the construction of that notorious vessel, which, by the way, was the only wooden vessel the Lairds had built since they commenced building in iron.

One day, during the noon hour, Master Carpenter Neilson was examining the work while the men were away, and dropped his rule in a rabbet in the keel, to gauge its depth. The hollow sound it made struck his practiced ear, and an investigation followed, revealing a defect which, if it had been allowed to remain, would inevitably have wrecked the vessel the first storm she encountered. Was this providential or otherwise? As Mark Twain observes, "There is this trouble about special providences, namely, there is too often a doubt as to which party was intended to be the beneficiary."

In Mr. Harrison's criticism of the "Victoria" disaster, I cannot help thinking that he is rather hard on Admiral Markham, who, according to his own showing, was very much in the same position as the man in Frank Stockton's story of "The Lady and the Tiger."

Had he refused to obey orders, his ship would have been rammed, and all the blame would have been laid on his shoulders, if he had survived. Whereas, if he obeyed orders, it would be the other fellow's ship that would be rammed, and he would be to blame, too. Truly a most unenviable position for any one to be placed in.

Dubuque, Iowa. F. THORNELY.

Indicator Connections.

Editor American Machinist:

It appears to me that those of your readers who still think that a foot, more or less, of ¼ inch pipe used in connecting an indicator to an engine will be accounted for by the indicator cards, should duplicate Mr. Willis' rig and repeat his experiments, rather than bolster up obsolete experiments as proof that his (Mr. W.'s) are not trustworthy. It will be remembered that Mr. Willis had no other object in view than to determine the influence a long and short pipe would have on a card. It should be also remembered that the methods he employed anticipated and effectually avoided all objectionable influences that are frequently present in experiments of this kind, which gives his experiments their great value. Until some one employs more delicate and accurate methods of measuring the very slight difference in the time and quantity of steam that

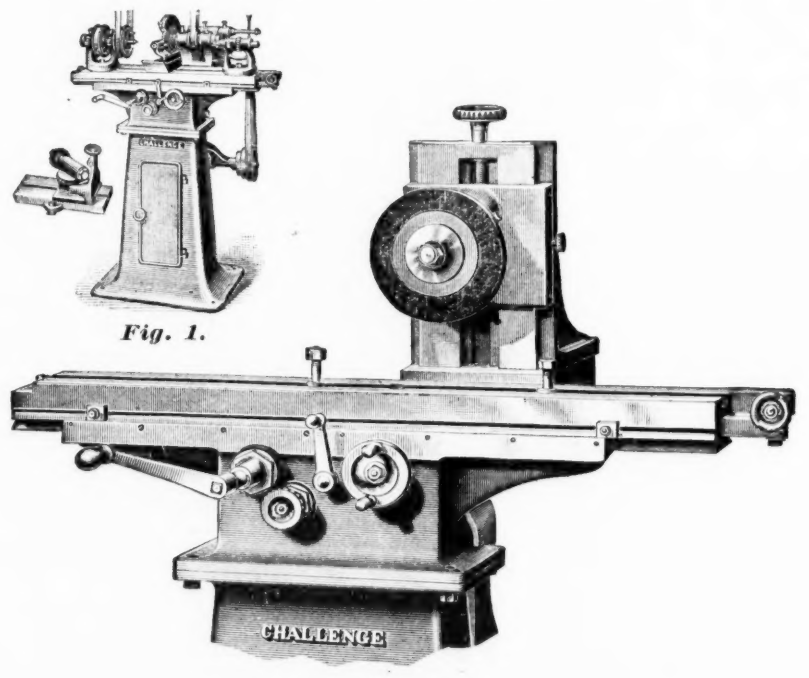


Fig. 1.

Fig. 2.

SURFACE GRINDER.

will travel through a ¼ inch pipe 1 foot or 1 inch long, all other conditions the same, we shall have to accept the result of Mr. W.'s experiments as being authority on the subject so far as connecting indicators are concerned.

Long pipe connections are not recommended, neither are short connections absolutely necessary for accurate indications.

C. O. SINE.

Self-propelling Fire Engines.

Editor American Machinist:

In your last issue I find the following item:

"It would seem as though all steam fire engines should be capable of propelling themselves to a fire instead of requiring horses for that service. A small cylinder of compressed air might be sufficient."

Why not abandon the steam fire engine altogether, and substitute electricity? Erect a system of wires same as for lighting purposes, with switches distributed same as fire hydrants, so as to be accessible to the firemen on the streets. Then construct a truck, on which is mounted an electric motor connected to a pump. Such trucks would be comparatively light, and could be run to fires very easily, and switched onto the wires without delay at all times and be ready for action.

The same could be accomplished with compressed air by laying distributing pipes, to which an air motor, instead of an electric motor, could be connected at the different distributing points.

In both cases the power would have to be supplied by main power stations.

It seems to me some such system would be far preferable over the present way of hauling the heavy cumbersome fire engines through the streets belching forth a volume of black smoke, and having to wait until steam can be raised to bring the machines into action.

I give this for what it is worth, and would like to hear from others on this subject.

Chicago, Ill. J. NEUERT, M. E.

Hardening Plug and Ring Gauges.

Editor American Machinist:

If W. R. G. will make those ring and plug gauges of steel low in carbon, say ⅞ to 1 per cent. carbon (cold chisel steel) and heat them slowly to a low red heat, they will be very hard and will not break. I have made lots of them. A 1 inch ring gauge should be heated so slowly that it will take 20 minutes by the clock (not by guess) to bring it to a proper heat. Use a large charcoal fire, and apply little or no blast.

NAME RAFT.

Reflector for Water Gauges.

Editor American Machinist:

It appears that our engineer does not believe in straining his eyesight when looking at the glass water gauge, for he has arranged a neat contrivance which shows the water red as a red rose.

For the benefit of those who may not have seen such a device I will try and describe it:

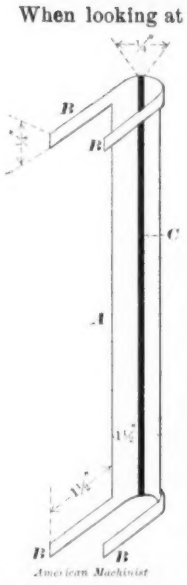
Take a piece of bright tin or nickel-plated thin sheet metal 1½ inches wide in the body *A*, and as long as the gauge glass. At the four corners four strips or arms *B*, *B*, *B*, *B*, are left projecting when cutting the sheet, the arms to be about ¼ inch wide and 1½ inches long.

Now curve the plate as shown in the sketch so that it will touch the hexagon corners of the brass glands which hold the glass in position.

Along the center of the concave surface on the plate, which acts as a reflector, there is to be painted a bright red stripe *C*, about $\frac{3}{16}$ or ¼ inch wide; when this is dry get some shellac, such as patternmakers use, and give the concave surface a coat or two of the shellac, which will serve to retain the luster on the reflector.

It is now ready to be placed in position behind the glass, the arms *B* are to be bent over the two brass front rods which protect the glass, and the upper and lower ends of the body *A* are pressed against the brass glands, thus holding the reflector in position at a little distance from the glass.

When looking at the glass from the front the water appears red, and the stripe on the reflector above the water line, although it can be seen, will appear not over ⅛ inch wide.



The appearance is somewhat changed by looking at it from other points of view, thus the red line may be seen above the water whilst the water appears in its natural state when looking at it about 25 degrees from the former position.

To remove the reflector simply take out the brass rods.

For some water gauges the sizes might have to be modified.

CHARLES A. CALVERT.

Buffalo, N. Y.

Turning Ball Valves.

Editor American Machinist:

I see in the AMERICAN MACHINIST of April 19th, a correspondent asks for information how to turn brass ball valves a true sphere and have them balanced. Those above 2 inches and to 10 inches diameter are hollow. Those under 2 inches diameter are solid, and he will have no trouble to turn them true and have them balanced. But those over 2 inches diameter are what will cost him some new tools.

If I were going to have those made I would have them cast with a hole straight through them, and would rig up a number of solid ball chucks to fit some hollow spindle lathe, and have them bored out inside to fit each size ball valve, and with a hinged yoke clamp to secure ball in chuck. Have a hole in chuck to let the chips and sand dust out through hollow spindle of lathe, and have a funnel and pipe leading to a box to receive chips. Then, with boring bar, as Fig. 1, with a swinging cutter, a spring to return cutter to place, and a hole through center of cutter bar, to connect a hose from fan blower or air compressor, to remove dust and chips. The inside may be bored out practically a true sphere, through the large hole, before threading. Threads in both holes should be finished before removing from chuck.

In Fig. 1 tool in cutter bar is fed out by the point of hand screw, and it should fit the hole in bar close, and have a ball point. The spring returns cutter to place when hand screw is screwed back. The hole through the center of bar for fan blast comes out between cutter and spring, and keeps that part of cutter clean; you will notice the cutter starts out at the edge of

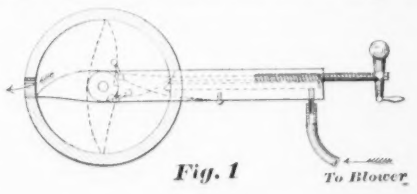


Fig. 1

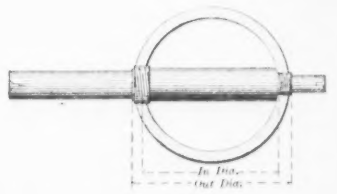


Fig. 2

inside hole, first on front side, then the back of outside hole (and only travels one-fourth of the circle, cutting at both points at the same time), that is to throw the chips down from the cutter and assist the blower in cleaning the cutter.

The end of the bar (Fig. 1) should be round, and nearly the size of the hole, where it passes through the ball, to aid the operator in centering the same, and the fan blast in throwing the chips and dust out through the hollow spindle of lathe.

In the larger size of balls the blast could be left off, and would only need one hole in ball, for there is room for chips in bottom of ball, not being much material removed.

For turning the balls I would use a mandrel that would go through both holes, and have shoulders turned on the mandrel to correspond to the diameter of the ball, for starting tool and stopping same, to act as a gauge (see Fig. 2) with a shoulder on mandrel, to screw up against inside-boring of ball, to insure having the ball the same thickness at all points.

For turning off the ball valves, he could use any of the spherical lathe attachments shown in the AMERICAN MACHINIST of April 15, 1882; October 4, 1884; October 20, 1888, and more in other issues. And, if he wants an absolute sphere, let him use the three-emery-wheel plan to finish, as shown in the AMERICAN MACHINIST of May 5, 1892, and if he uses the emery wheels, he need only rough-turn the ball valves.

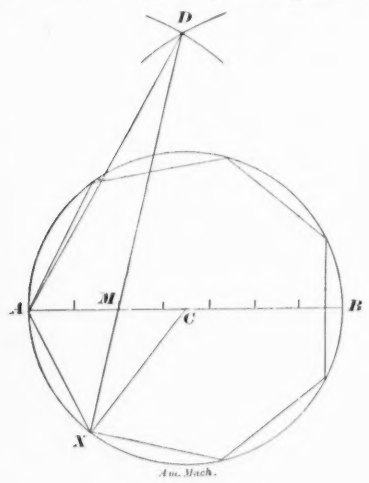
HALE G. ROBINSON.

Port Huron, Mich.

Heptagon.

Editor American Machinist:

Having looked week after week in vain for Mr. Dupries' promised solution of his method for the construction of a heptagon, and as many of your readers are evidently much interested in the subject and may be anxious to know how far it may be relied on for accuracy, the accompanying mathematical analysis of the essential elements of the figure may prove acceptable. In the triangle $A\ D\ M$, the angle at A is 60°, and $A\ D = A\ B$, which contains seven units, while $A\ M$ contains two of the same units. The triangle can, therefore, be solved. The side $D\ M$ is first found by the trigonometri-



HEPTAGON.

cal formula, which expresses the cosine of an angle in terms of the sides, viz.:

$$\text{Cos. } D\ A\ M = \frac{(A\ D)^2 + (A\ M)^2 - (D\ M)^2}{2\ .\ A\ D\ .\ A\ M}$$

This gives $\sqrt{39}$, or 6 244998 as the value of $D\ M$.

Then sin. $D\ M\ A$: sin. $D\ A\ M$: : $A\ D$: $D\ M$; sin. $D\ M\ A$ is, therefore, equal to $\frac{7}{6}\sqrt{13}$, *i. e.*, to .970735.

And the angle $C\ M\ X$ is equal to the angle $D\ M\ A$. Thus, $M\ X$, a side of the triangle $M\ C\ X$, can be found in the same way as $D\ M$ was determined in terms of the unit expressing the seventh part of the diameter of our circumscribing circle.

Of course, the cosine of angle $C\ M\ X$ must first be obtained from the known value of the sine; and it should be noticed in this connection that although a double sign occurs before the resultant number, *viz.*, $\pm \frac{\sqrt{39}}{26}$, the plus sign must, of necessity, be rejected since $C\ M\ X$ is obviously an obtuse angle. I find the length of $M\ X$ to be 2.822447 of our adopted units.

Finally,

$$\text{sin. } M\ C\ X = 2.822447 \times \tfrac{2}{7} \times \text{sin } C\ M\ X$$
$$= 2.822447 \times \tfrac{2}{7} \times \frac{7\sqrt{13}}{26}$$
$$= .782806.$$

The angle is, therefore, 51° 31′ nearly, so that the error approximates 5′ or $\frac{1}{12}$ of a degree, which may be neglected in practice, since it is less than the four-thousandth part of the circumference, and is not more than results from taking 3.1416 as the value of π. Mr. Dupries deserves the thanks of your readers for giving publicity to the method, though he *may be* only the *accidental* discoverer, as your correspondent C A. Calvert suggests. But Mr. Dupries deduces the fact (for fact it is) not noticed in Late's Geometry, that the method is applicable to the construction of other regular polygons besides the heptagon. In conclusion, I would point out to Mr. Calvert that no student of Late's "Practical Geometry" would need to divide a straight line into any number of parts *by trial*, as the ordinary method explained in his text-book enables him to do it with absolute accuracy.

WILLIAM COBHAM.

Sparrow's Point, Md.

A New Planimeter.

Editor American Machinist:

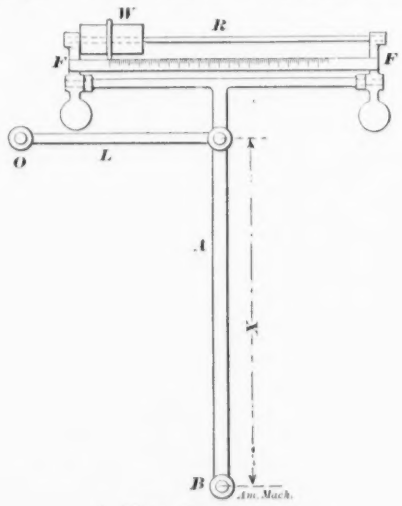
The accuracy of planimeters being at present under discussion in your columns my experience may interest some of your readers.

About 10 or 12 years ago I made one to measure surfaces containing from 20 to 30 square feet. The wheel was about 4 inches in diameter, the rim was of hardened steel, carefully rounded and polished. Upon testing the instrument by leading the point repeatedly over the same outline, I found differences by far exceeding the probable inaccuracy in leading the point. The error was obviously introduced by an accidental turning of the wheel while slipping over the surface on which the measuring wheel rested. I tried various surfaces, ground and polished, hard and soft, but to no purpose.

I considered whether or not this trouble can be met mechanically. I argued that if it were possible to provide the periphery of the wheel with very thin, small friction wheels, to prevent a sliding action as the wheel is moved in a direction of its axis, the difficulty would be overcome. This, of course, is impossible, but this thought suggested the following modification, which gave very satisfactory results. The appended sketch does not show the best form of construction, but serves to show the principle.

A is the T shaped bar with the tracing point B at its end. L is the link with the fixed fulcrum O. To the bar A is hinged the frame $F\ F$, which carries the rod R which passes through the bore of the wheel W. The frame is balanced by counterweights to reduce the friction of the rod R in the wheel W. The wheel rests on the rolling surface merely by its own weight, and it never slides on it, the sliding effect being transferred to the rod R. The wheel is made as heavy as practicable and is provided with a raised ring to enable it to freely change its angular position.

The area of the surface inclosed by the line over which the point B is traced is equal to the product of the linear displacement of the wheel on the rod R into the length X of the bar A. The area is ac-



A NEW PLANIMETER.

cordingly measured by the linear instead of the rotary displacement. This motion being limited a smaller scale must be chosen than is admissible in the usual form of planimeters. But since the errors inherent in the usual form exceed many times the personal equation in reading the scale, this reduction of the scale is no objection.

In using this instrument care must be taken to prevent the wheel from returning to the zero point by beginning at a point of the left-hand margin of the surface to be measured. A little experience will soon teach where to start in any special case, so as to prevent a slipping of the wheel on the rolling surface by reason of the frame colliding with it.

When the point of this instrument was repeatedly traced over the same outline a difference in the recorded measurement was no longer observed. HUGO BILGRAM.

Philadelphia, Pa.

The Isometric Ellipse.

Editor American Machinist:

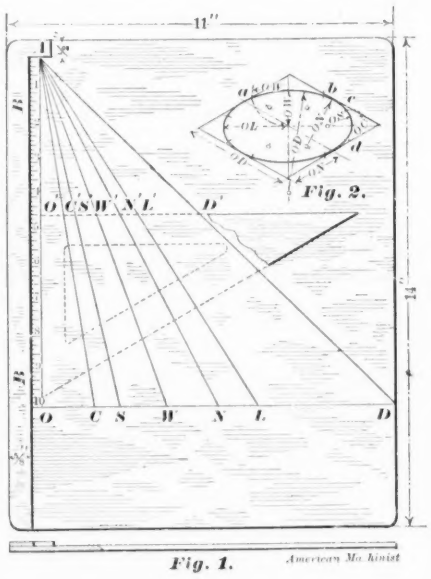
Thinking that a ready method of obtaining the proportions of the isometric ellipse would be of use to some of your readers, I inclose drawing and brief description of a device which has proved very useful to me in patent and descriptive drawing.

Fig. 1 is a graphic scale made with India ink on heavy cardboard.

The distances set off on the horizontal line $O\ D$ are as follows:

$O\ C = 1\frac{1}{2}''$,
$O\ S = 2\frac{5}{16}''$,
$O\ W = 3\frac{17}{32}''$,
$O\ N = 5''$,
$O\ L = 6\frac{1}{8}''$,
$A\ O$ and $O\ D = 10''$ each.

$O\ D$ = diameter of circle to be repre-



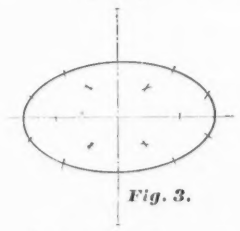


Fig. 3.

ISOMETRIC ELLIPSE.

sented. It is also equal to the side of circumscribed isometric square, and equals the radius of the arcs $a\ b$ at the extremities of minor axis.

$O\ L = \frac{1}{2}$ major axis.

$O\ W = \frac{1}{2}$ minor axis, and is also used as a chord to measure the length of arcs $a - b$, as shown in Fig. 2.

$O\ S$ = radius of arcs $c - d$ at extremities of major axis.

$O\ C$ = chord to measure the length of arcs $c - d$.

$O\ N$ = radius of intermediate arcs $b - c$.

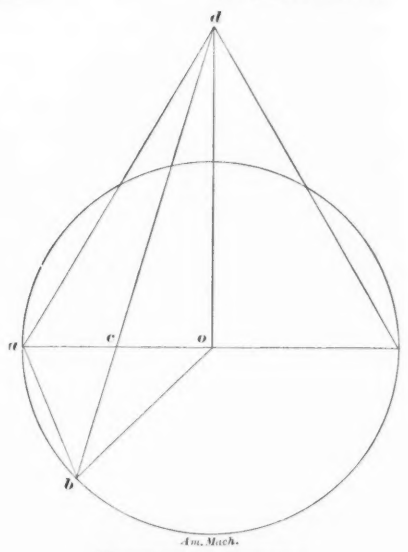
A piece of cardboard or thin wood, $B\ B$, is glued to the upper surface on the left to serve as a guide for triangle in drawing horizontal lines, its upper end being extended to the right at A, so that in using odd scales measurement can be made directly between this block or 0 mark and the upper edge of triangle.

In using the scale, a horizontal line is drawn opposite the division on the graduated scale, which represents the size of circle to be put into isometric. It is drawn in pencil so that it can be removed with a rubber when no longer required for further use.

Having on the drawing the horizontal and vertical center lines, take the distance $O'\ L'$ and set it off on the major axis on each side of the center.

Then take $O'\ W'$ and space off on each side of the center along the minor axis, giving the bounding points of the ellipse. With the length $O'\ W'$, also set off the length of arcs $a - b$, Fig. 2, and with $O'\ D$ as a radius draw these arcs.

$O\ C$ is then taken and the length of the arcs $c - d$ set off on drawing, and with radius $O\ S$ these are also drawn, as shown in Fig. 2. All that remains to complete the figure is to draw the four connecting arcs with the radius $O\ N$ in the usual manner. As shown in Fig. 3, it is only necessary to draw very slight pencil lines to determine the points and centers, which keeps the drawing quite free from confusing lines. W. D. RUNDLETT.



Regular Polygons.

Editor American Machinist:

The approximate rule for inscribing a regular polygon within a given circle, explained by your correspondent in your issue of April 5th, is applicable only for a small number of sides. The error increases as the number of sides increases.

The error for any given number of sides is easily computed. To do this we must find the value of the angle $a\ o\ b$, and compare it with the *true* value of the angle subtended by the side of the regular polygon.

We begin by finding the angle $o\ c\ d$ whose tangent $= \frac{o\ d}{o\ c}$.

Calling the radius unity, $o\ d$ is the height of an equilateral triangle whose side = 2, *i. e.*, $o\ d = \sqrt{3}$; and $o\ c = 1 - a\ c$. The length of $a\ c$ depends upon the number of sides of the polygon which we will call n. The point c, according to the rule, is determined by laying off $a\ c = 2\frac{D}{n}$, D being the diameter of the circle. But $D = 2$. $\therefore\ a\ c = \frac{4}{n}$, and $o\ c = 1 - \frac{4}{n} = \frac{n-4}{n}$; $\therefore$ tan $o\ c\ d = \frac{n\sqrt{3}}{n-4}$

From this we determine the value of the angle $o\ c\ d$; and then its supplement $o\ c\ b$.

The angle $o\ b\ c$ is found by the proportion

$$\text{sin. } o\ b\ c : \text{sin } o\ c\ b :: o\ c : o\ b (= 1)$$
$$\therefore \text{ sin. } o\ b\ c = o\ c \times \text{sin } o\ c\ b$$

The required angle $c\ o\ b = 180° - (o\ c\ b + o\ b\ c.)$

Computing the angle $a\ o\ b$ in this way I find for the pentagon that the accumulated error on stepping the chord five times round the circumference is about $\frac{1}{4}°$ in defect; for the heptagon the total error is about $\frac{1}{2}°$ in excess. For the decagon the total error is between 3° and 4° in excess. For 20 sides the total error is between 12° and 13° in excess. FREDERIC R HONEY.

Strength of Beams.

Editor American Machinist:

Having read with great interest the different articles recently published in the AMERICAN MACHINIST relating to strength of beams, I also wish to add a few remarks of my own experience and opinion on this subject. That the neutral axis is always in the center of gravity of section of a cast-iron beam of any form of section, and under any

load, looks to me a very difficult problem to prove. We may experiment or we may quote from standard authors, but I do still believe there is a little more to say about the question. Mr. Mackintosh has done a good thing in bringing up this subject, and when a man investigates and thinks for himself, and also gives his opinion in the AMERICAN MACHINIST for the benefit of others, we should not try to make it appear as if this man disregards the opinion of standard authors. Haswell says: The examination of facts is the foundation of science. After reading Mr. Mackintosh's letters, and the answers his communications called out in the AMERICAN MACHINIST, I had some proof pieces cast of sections shown in Figs. 1 and 2, which I tested in a testing machine. When placed in position as in Fig. 1, supported under both ends, 1 foot between supports, and loaded in the middle, the two specimens broke at, respectively, 3,275 pounds and 3,325 pounds, giving a mean strength of 3,300 pounds.

Two other specimens were tested exactly the same way, only they were placed in the reverse position, shown in Fig. 2, 1 foot between supports, and loaded in the middle; they broke, respectively, at 2,100 pounds and 1,975 pounds, this gives a mean for these two specimens of 2,037½ pounds.

This simply proves what we all know, that the ultimate breaking strength of a cast-iron T-beam is greatest when it is placed in such a position that the larger side is exposed to tensile strain.

But there is something more at the back of this—the stiffness of the beam. We will find that for a moderate load the specimens placed as in Fig. 1 are not any stiffer than when placed as in Fig. 2. When the load is small, we find the beam deflects just the same in one position as in another, although the ultimate breaking strength is considerably different.

We all know cast iron has about five to

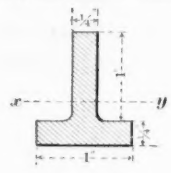


Fig. 1

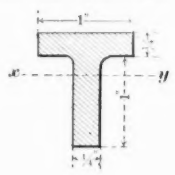


Fig. 2

six times as much ultimate crushing strength as ultimate tensile strength, but we also know that if we subject cast-iron only to a moderate strain it will yield about as much under compressive strain as it would under tensile strain. That is, if we take a bar of cast-iron and subject it, for instance, to a tensile strain of 50,000 pounds, and its section is large enough to keep the stress well within its elastic limit, we find the bar under the load to be extended a certain fraction of its length. If the load is removed the bar will again assume its original length. If we now subject the same bar to a load of 50,000 pounds of crushing strain, it will be compressed or shortened the same amount as it was lengthened when under tensile strain Therefore we have the same modulus of elasticity for both tension and compression in cast-iron.

Or, still better, let us assume two bars of same kind of cast-iron, and of same size, loaded within their elastic limit with 50,000 pounds, one bar being subjected to a tensile strain, and the other bar to a compressive strain, we shall find both to yield just the same amount, and if we increase the load they will both yield alike in proportion to their load until they reach their elastic limit, the one under tensile strain will then commence to give away more rapidly and not at all in proportion to the load, but considerably faster. The other one subjected to crushing strain will, when approaching the elastic limit, not shorten in proportion to the load, but a great deal slower, until a point is reached where the cast-iron cannot be further compressed, and then the bar must burst.

Now, let us return to our cast iron beam supported under both ends, and loaded in the middle, having its neutral axis in its center of gravity on line $x\ y$; every particle of cast-iron below the neutral axis is under tensile strain in proportion to its distance frem the neutral axis. Every particle of cast-iron above the neutral axis is under compressive strain in proportion to its distance from the neutral axis.

It is now safe to say that as long as the upper side is yielding to compression as fast as the lower side is yielding to extension, the neutral axis will remain in the center of gravity of section as these two forces must balance one another. But when the load is increased to an extent where that part of section which is exposed to compression is yielding less than that part of section exposed to extension, I believe it must be reasonable to assume that the neutral axis, as the load increases, must tend to move towards the side exposed to compressive strain in order that the tensile strain and the crushing strain may balance one another. We must always remember that the term neutral axis of a beam means the place where the fibers are not subjected to a tensile or compressive strain.

If the neutral axis is always in the center of gravity of section in a cast-iron beam loaded transversely, under any load, why should specimens tested show such difference in ultimate breaking strength when placed in the positions shown in the figures?

Undoubtedly the neutral axis in any cast iron beam is in the center of gravity of section so long as the load is moderate—well within the elastic limit of the beam—but when the beam becomes excessively loaded can any one prove that the neutral will, in all cases, pass through the center of gravity of the section? P. LOBBEN.

Comparison of Various Rules for Area of Lever Safety Valves.

BY WILLIAM KENT, M E.

The writer has for some time been engaged in the preparation of a new pocket-book for mechanical engineers. The chief difficulty in such a work, next to the labor of searching for information and rejecting 99 per cent. of the information found, on account of its unavailability for the purpose, is that of arriving at a conclusion as to the relative probable accuracy of conflicting rules and formulæ given by different writers. An example of the conflicting rules referred to is found in the following study of the question of the size of safety valve required for a given boiler. The writer will be obliged if any reader of the AMERICAN MACHINIST will give him a reliable rule or formula for safety valves, or experimental data from which a formula may be derived.

Assume the case of a boiler rated at 100 horse-power; 40 square feet grate; 1 200 square feet heating surface; using 400 pounds of coal per hour, or 10 pounds per square foot of grate per hour, and evaporating 3,600 pounds of water, or 3 pounds per square foot of heating surface per hour; steam pressure by gauge, 100 pounds. What size of safety valve, of the lever type, should be required?

A compilation of various rules for finding the area of the safety-valve disk is given in *The Locomotive* of July, 1892, which is given in abridged form below, together with the area calculated by each rule for the above example:

	Disk Area in sq. Inches.
U. S. Supervisors, heating surface in square feet ÷ 25*	48
English Board of Trade, grate surface in square feet ÷ 2	20
Molesworth, four-fifths of grate surface in square feet	32
Thurston, 4 times coal burned per hour × (gauge pressure + 10)	14.5
Thurston, $\frac{1}{45}$ $\frac{(5 \times \text{heating surface})}{\text{gauge pressure} + 10}$	27 3
Rankine, .006 × water evaporated per hour.	21.6
Committee of U. S. Supervisors, .005 × water evaporated per hour	18

Suppose that other data remaining the same the draught were increased so as to burn 13⅓ pounds coal per square foot of grate per hour, and the grate surface cut down to 30 square feet to correspond, making the coal burned per hour, 400 pounds, and the water evaporated, 3,600 pounds, the same as before, then the English Board of Trade rule and Molesworth's rule would give an area of disk of only 15 and 24 square inches, respectively, showing the absurdity of making the area of grate the basis of the calculation of disk area.

Another rule by Professor Thurston is given in AMERICAN MACHINIST, December, 1877, viz.:

Disk area =

$$\frac{\frac{1}{4} \text{ max. wt. of water evap. per hour}}{\text{gauge pressure} + 10}.$$

This gives for the example considered 16 4 square inches.

One rule by Rankine is $\frac{1}{150}$ to $\frac{1}{180}$ of the number of pounds of water evaporated per hour, equals for the above case 27 to 20 square inches. A communication in *Power*, July, 1890, gives two other rules:

1st. 1 square inch disk area for 3 square feet grate, which would give 13.3 square inches.

2d. ¾ square inch disk area for 1 square foot grate, which would give 30 square inches; but if the grate surface were reduced to 30 square feet on account of increased draught, these rules would make the disk area only 10 and 22.5 square inches respectively.

The Philadelphia rule for 100 pounds gauge pressure gives a disk area of 0.21 square inch for each square foot of grate area, which would give an area of 8.4 square inches for 40 square feet grate, and only 6 3 square inches if the grate is reduced to 30 square feet.

According to the rule this aggregate area would have to be divided between two valves. But if the boiler was driven by forced draught then the inspector "must estimate the area of grate at one square foot for each 16 pounds of fuel burned per hour."

Under this condition the actual grate surface might be cut down to 400 ÷ 16 = 25 square feet, and by the rule the combined area of the two safety valves would be only 25 × 0.21 = 5.25 square inches.

Nystrom's Pocket book, edition of 1891, gives ¾ square inch for 1 square foot grate; also quoting from Weisbach, Vol. II., $\frac{1}{3000}$ of the heat ing surface. This in the case considered is $\frac{1200}{3000}$ = .4 square foot, or 57.6 square inches.

We thus have rules which give for the area of safety valve of the same 100 horse-power boiler results ranging all the way from 5 25 to 57.6 square inches.

A "logical" method for calculating the size of safety valve is given in *The Locomotive* July, 1892, based on the assumption that the actual opening should be sufficient to discharge all the steam generated by the boiler. Rankine's rule for flow of steam is taken, viz., flow through aperture of one square inch in pounds per second = $\frac{\text{abs. pressure}}{70}$, or in pounds per hour = 51 43 × absolute pressure.

If the angle of the seat is 45 degrees, as specified in the rules of the U. S. supervisors, the area of opening in square inches = circumference of the disk × the lift × .71, .71 being the cosine of 45 degrees; or diameter of disk × lift × 2.23.

In the example under consideration, 3,600 pounds of steam to be discharged per hour, according to Rankine's rule would require an aperture of $\frac{3{,}600}{51.43 \times 115}$ = .61 square inch. If we assume the lift at .04 inch, then diameter of disk = $\frac{.61}{2\ 23 \times 04}$ = 6 8 inches, or area of disk = 36.3 square inches.

The assumed lift is taken from the following:

TABLE OF THE "LIFT" OF SIX LEVER SAFETY VALVES, ACCORDING TO THE EXPERIMENTS OF THE U. S. BOARD OF SUPERVISING INSPECTORS OF STEAM VESSELS.*

Pressures at which Valves were Set.	AREA OF VALVE IN SQUARE INCHES.					
	5.	10.	15.	20.	25.	30.
10 lbs.	0″.20	0″.19	0″.17	0″.17	0″.15	0″.16
20 "	.20	.18	.12	.13	.10	.11
30 "	.13	.13	.08	.08	.09	.10
40 "	.15	.11	.08	.09	.08	.06
50 "	.14	.11	.08	.10	.04	.04
60 "	.09	.09	.05	.08	.05	.04
70 "	.06	.09	.05	.04	.04	.03
80 "	.08	.06	.04	.03	.04	.02
90 "	.06	.06	.04	.....	.....	.....
100 "	.05	.06	.03	.....	.....	.....

* See their special committee's *Report on Safety Valve Tests*, 1877.

The above table is notable for its inconsistencies, thus the valve of 20 square inches in area lifts much more than either the 15 or the 25-inch valve at 60 pounds pressure, and less than either at 80 pounds. With 80 pounds pressure the table gives a smaller actual area of aperture for a valve of 30 square inches area than for one only 5 square inches area, the product of the circumference by the lift being 19 41 × .02 = 38 82 in the case of the larger valve, and 7.92 × 08 = 63 36 for the smaller. Our assumption of a lift of .04 inch may therefore be wide of the truth, and the "logical" method of calculating the area of the disk therefore falls for lack of probable accuracy of the data used.

All of the rules above quoted give the area of the disk of the valve as the thing to be ascertained, and it is this area which is supposed to bear some direct ratio to the grate surface, to the heating surface, to the water evaporated, etc. It is difficult to see why this area has been considered even approximately proportional to these quantities, for, with small lifts, the area of actual opening bears a direct ratio not to the area of disk, but to the circumference.

Thus for various diameters of valve:

Diameter =	1	2	3	4	5	6	7
Area =	.785	3.14	7.07	12.57	19.64	28 27	38.48
Circum. =	3.14	6 28	9.42	12 57	15 71	18.85	21.99
Circum. × lift of 0 1 in =	31	.63	.94	1.26	1.57	1 89	2.20
Ratio to area =	.4	.2	.13	.1	.08	.067	.057

The apertures, therefore, are directly proportional to the diameter or to the circumference, but their relation to the area is a varying one.

If the lift = ¼ diameter, then the opening would be equal to the area of the disk, for circumference × ¼ diameter = area, but such a lift is far beyond the actual lift of an ordinary safety valve.

A correct rule for size of safety valves should make the product of the diameter and the lift proportional to the weight of steam to be discharged.

It is not possible at present to establish such a rule, first, for lack of knowledge of the actual lifts of valves of different diameters under different pressures, and, second, for want of a consensus of opinion as to what should be required of a safety valve. Should it be made large enough to be capable of discharging all the steam that can be made by the boiler when evaporating at its maximum rate, the engine and all other outlets for steam being shut off? Should it be capable of discharging this steam at the working pressure, or at what pressure above the working pressure? Or, is it sufficient to have it only large enough to discharge such steam as might be evaporated after shutting the damper, or as might be accidentally generated by radiation from the furnace walls after the fires have been banked and the boiler left for the night?

If we assume that .04 inch is the lift of a safety valve under 100 pounds gauge pressure, that the discharge per square inch of aperture for this pressure is 5,899 pounds per hour, according to Rankine's rule, that the aperture = diameter × .04 × 2.23 = .0892 × diameter, then each inch of diameter of safety valve will be equivalent to the discharging capacity of 525 pounds of steam per hour, and the discharge of different sizes will be as follows:

Diameter:										
1	1½	2	2½	3	3½	4	5	6	7
Pounds:										
525	787	1050	1312	1575	1837	2100	2625	3150	3675
Horse-power at 30 pounds:										
17.5	26.2	35	43.7	52.5	61.2	70	87.5	105	122.5

Expressed in the shape of a formula,

Diameter of safety valve in inches = $\frac{\text{lbs. water evap. per hour}}{525}$ or

$$\frac{\text{horse-power of boiler}}{17.5},$$

the horse power being taken as an evaporation of 30 pounds of water per hour.

It is customary in practice not to use safety valves of greater diameter than 4 inches. If a greater diameter is called for by the rule that is adopted, then two or more valves are used instead of one.

(* The latest edition (1893) of the Rules of the Supervisors does not contain this rule, but gives the rule grate surface ÷ 2).

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NEW YORK, MAY 24, 1894.

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Let Something Be Done.

It is probably entirely within the mark to say that there has seldom, if ever, been such complete and universal disgust with Congress as is manifested at the present time.

Nearly every man we meet, regardless of party affiliations or prejudices, is ready to declare his belief that it is being made plainly evident that broad minded statesmen are altogether too rare in Congress, and that the number of members who are ready to sacrifice their principles, the general welfare, and pretty much everything else, including their own dignity and self respect, for the sake of supposed party advantage, to further local interests, or to influence prices of stocks in Wall street, is altogether too large. There are sinister stories of bribery and of speculation in Wall street carried on by senators who are in a position to know what is or is not likely to be done with certain schedules, and Congress dallies, while business is paralyzed and honest workingmen walk the streets, or shoot themselves in sheer desperation, or that their families may get life insurance money.

The American people can and will exercise all the patience necessary with men who are believed to be carrying out their honest convictions in an honest and sincere manner, but when it comes to being trifled with, their patience cannot be expected to hold out indefinitely. The general demand is that something be done, and done immediately.

Steam Economy vs. No Steam.

Last week we published an item taken from the *Railway Review* in which the editor of that paper criticises a statement made in our columns by Mr. Harris Tabor, which statement was as follows:

"It is well known that steam cannot be expanded in locomotive cylinders to the extent that is called for in stationary engines, for the exhaust would not be sufficient to give the required draught."

This statement is evidently considered ridiculous by our contemporary, who says that "no one has ever before given it recognition, much less stamped it as a well known fact."

We have no doubt, however, that Mr. Tabor will stand by his assertion, and he well may, for nothing can be more true than that after the piston of a locomotive has made its stroke, the steam contained in the cylinder has still an important work to do. This work is to make a strong blast—to blow the fire, and in order to do this to anything like the extent required, it is necessary that expansion be not carried to or near the atmosphere, as is the case frequently with stationary engines.

It is quite true, as Mr. Tabor has stated, that the locomotive works under the disadvantage that at times when the cylinder can use steam with an approach to good economy, the terminal pressure will not be high enough to get nearly the maximum evaporation; and if our contemporary will take the trouble to make some inquiries among men who run locomotives it will find that there are many cases where a locomotive will keep up to its work only by using steam nearly full stroke and throttling, thus sacrificing economy in using steam for the sake of obtaining a supply of steam sufficient to keep moving.

From the experience with the torpedo boats "Cushing" and "Stiletto" in stealing into Newport Harbor without being observed, in spite of the fact that officers, forewarned of their approach, and armed with the best modern search lights were stationed at the entrance of the harbor for the purpose of detecting them, would seem to indicate that a torpedo boat ought to be reasonably secure against destruction by shot from a naval vessel approached under cover of darkness, where the whole horizon must be covered by the search light, and where no warning is given of its approach. In this case the boats were for ten minutes in an open space where they could have been observed if the light had been thrown fairly upon them, and they had been sufficiently conspicuous to be seen. This, it seems, they were not; one of the boats was painted a dark green color, while the other was nearly black.

Last week we referred to the settlement by arbitration of the difficulties which had arisen between the employes and President Hill, of the Great Northern Railroad, in which settlement the men were awarded nearly all they had contended for. A further difficulty, however, arose in regard to the interpretation of the award, and for a time seemed to threaten the renewal of active hostilities. This was avoided by calling upon the arbitration committee to interpret its own award, which it did by again granting all the men were contending for, and ordering the restoration to their places of men who had been suspended or discharged.

It would seem as though this experience with arbitration would certainly encourage the new railroad employes' organization to favor that method of settling such difficulties in the future, though there is, perhaps, not so much encouragement in it for the railroad officials. These have one protection, however, against such sweeping awards, and that is to have cases which will appeal to fair-minded men of affairs; which, no one denies, the members of the arbitration committee were. The men contended from the first that the dispute was an entirely one sided affair, and the arbitration committee seemed to take the same view of it, though it does not follow from this, of course, that all such disputes are, or will be judged to be, equally one sided.

Almost the single branch of manufacturing which can be contemplated with reasonable satisfaction at present, is that of making bicycles, which seem to be constantly growing in favor as a means of locomotion, of recreation, and of sport. The reduction in price made at the beginning of the season has resulted in increased business, especially for the makers of the higher grades of wheels, though, of course, the effect of the general depression is felt in this business as in others.

Tool builders are getting some business with the bicycle factories, and, in fact, have in some cases found here their chief encouragement to keep their shops running.

Death of Ambrose Webster.

As we go to press we are informed that Mr. Ambrose Webster, who is well known to our readers, and to mechanics generally the world over, died suddenly in Beaucourt, France, May 16th. Particulars are not at hand, but will be given later.

Literary Notes.

THE ELECTRIC TRANSMISSION OF INTELLIGENCE AND OTHER ADVANCED PRIMERS OF ELECTRICITY. By Edwin J. Houston, A. M., Professor of Natural Philosophy and Physical Geography in the Central High School of Philadelphia; Professor of Physics in the Franklin Institute of Pennsylvania, Electrician of the International Electrical Exhibition, etc.

This is the third and concluding volume of Professor Houston's advanced primers of electricity. It is as far as possible complete in itself, and there is no necessary connection between it and the other two volumes of the series.

The different chapters treat on the electric telegraph; multiple telegraphy; cable telegraphy; electric annunciators and alarms; time telegraphy; the telephone; electrolysis; electric metallurgy; storage or secondary batteries; electricity in warfare, electric welding; some other application of electricity, and electro-therapeutics.

Readers who wish to become acquainted with the above subjects in a general way will find this work to be well adapted for the purpose. The subjects are handled in an interesting and instructive manner, placing the first principles in such a light as to be easily comprehended by any reader.

The extracts from standard electrical books, for the purpose of giving the reader some idea of their character, and thus enabling him to select those best suited to his needs is an important and valuable feature of the work.

The book contains 330 pages and 88 illustrations. It is published by The W. J. Johnston Company, Limited, 41 Park Row, New York. Price, $1.00.

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS. By Francis B. Crocker, Professor of Electrical Engineering, Columbia College, New York, etc., and Schuyler S. Wheeler, D. Sc., Electrical Expert of the Board of Electrical Control, New York City, etc. With a Special Chapter by H. A. Foster. Second Edition, Revised and Enlarged.

This is probably one of the best books for practical men who have charge of the management of dynamos and motors. The more important facts which present themselves in the actual handling of dynamos and motors are set forth. Methods for examination, measurement, and testing are given, covering the various points about dynamos and motors which one is likely to want to test, including simple rough methods for emergencies or cases in which these machines may have to be tested without the accurate and expensive instruments required for more refined methods. The localization and remedy of troubles form an interesting and valuable feature of the book. For this purpose the authors have prepared a list of troubles, symptoms, and remedies, based upon experience with the various types and sizes of dynamos and motors in common use, covering nearly all the cases of trouble most likely to occur, so that the detection and remedy of the defect will result from a proper application of the rules given. "Arc Dynamos and Motors Requiring Especial Direction," by H. A. Foster, is a valuable addition to this edition. The authors do not claim for the treatment of subject much more than that it is a set of directions in which the various points are arranged under headings for convenience of reference. Nevertheless, the principle of action, similarity of dynamos and motors, their general form, construction, and much other useful information, such as the practical man should have for an intelligent conception of the power under his control, are given. All the subjects and directions are presented in a manner easily understood, conveying valuable information to the student and all interested in, or who may be responsible for the proper working of these machines. The book is published by D. Van Nostrand Company, 23 Murray and 27 Warren streets, New York. Price, $1.00

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(249) G. I. H., Chicago, Ill., asks questions which are entirely out of our line. Probably the best way to obtain the desired information is to write to a first-class daily paper in San Francisco, Cal.

(250) G. W. R., Sunbury, Pa., writes: Kindly inform me how I can blue gun barrels like those used in military service. *A.*—See answer to Question 230 in our issue of May 10th, current volume.

(251) J. G. D., Springfield, O., writes: In your answer to Question 166 you state that the number of revolutions of the revolving wheel around the stationary wheel will be one. Now, will it not be two? *A.*—See answer to Question 192 in our issue of April 19th, current volume.

(252) S. K., Cleveland, O., writes: I would be pleased to learn through your columns of some method of making reproductions of drawings, giving white lines on black ground. *A.*—The process which is of practical value, we believe, is patented. It is a silver process, and parties that are in the business do not care to divulge the secret.

(253) R. C. R., Englewood, N. J., writes: Can you give me any more information in regard to the nickel-in-the slot machines

made for blackening shoes than you kindly gave in answer to my Question 622 in your issue of December 28, 1893? *A.*—We would be glad to do so if we had an opportunity to examine one of these machines, but they have not yet been put in general use. We have the will but lack the opportunity of giving you the information you desire.

(254) F. T. O., ——, N. Y., writes: Please inform me of a reliable substance for the prevention of the formation of scale in a boiler. *A.*—Much depends on the kind of scale formed; we should try kerosene oil, and use 1 quart per day for each 100 horse-power. The water should be blown down two gauges every week, and the entire contents every month. In many cases the use of kerosene will also prevent the formation of scale. Rubber packing for the glass water tube and kerosene do not agree; hence use asbestos wicking dipped in boiled oil and then squeeze dry for packing.

(255) H. G., Philadelphia, Pa., writes: Please inform me through your columns which are good books on pumping machinery and air compressors. Are there any books treating on the above subjects sufficiently complete to enable one to design such machinery? Mathematical formulas would not be an objection, except calculus, which I have never studied. *A.*—"Pumping Machinery," by W. M. Barr, published by the author, 3223 Powelton avenue, Philadelphia, is a good book, and may answer your purpose. We do not know of any book that treats on air compressors only. You will probably find more on this subject in Appleton's "Cyclopedia of Applied Mechanics," or in the "Supplement of the Dictionary of Engineering," published by Spon & Chamberlain, than in many other books. We believe the articles on air compression, published in our columns, will be great aid to you in designing air compressors.

(256) G. N., Brooklyn, N. Y., asks: What should be the radius of an ordinary link for marine engines? 2. Can the same radius be used for all kinds of links, both slotted and otherwise? *A.*—The radius of the link arc in all shifting links of the Stephenson type, whether made open or solid, or those made of the box form, is generally equal to the length of the eccentric rods when the eccentric rod pins are on the link arc; but if these pins are back of the link arc, that is between the shaft and the link arc, the radius is equal to the length of the eccentric rod plus the distance the pins are back of this arc. By the length of the eccentric rod is meant the distance from the center of the eccentric strap to the center of eccentric rod pin. Some designers make this radius a little longer or shorter to suit given conditions or individual preference. For stationary links the radius of the link arc should be equal to the length of the radius rod. 3. Which is a good book treating on electricity for a mechanic to study who has no knowledge of this subject? *A.*—"Electricity and Magnetism," by S. P. Thompson, is a good book to commence with.

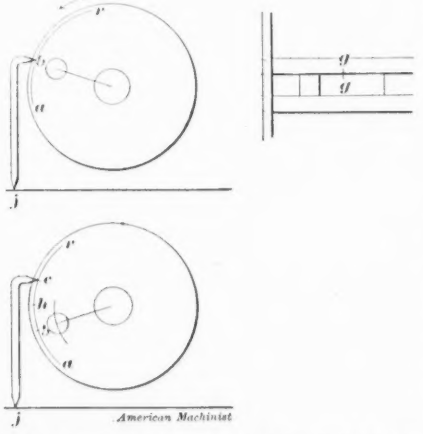
(257) A. S., Doon, Ia., writes: I would like to know the best method of turning the crosshead pins which are cast to the crossheads. *A.*—The device which we have illustrated in our issue of April 14, 1888, appears to be well calculated to do this kind of work. It is an attachment that can be applied to any lathe of ordinary make. It consists of a pinion securely fastened on one end of a sleeve, this sleeve having a thread inside of it, so that it can be secured on the lathe spindle in place of the ordinary face-plate. There is also a loose pinion and a chuck adjustably secured to it, adapted to rotate on the sleeve of the tight pinion, and a large gear-wheel intermeshing with the tight pinion, and operating a rack pitman which intermeshes with the loose pinion, rotating the loose pinion and attached chuck back and forth. In operation the crosshead is centered on the ordinary lathe centers, and secured in the chuck so that they rotate forward and back together. The cutting tool is an ordinary lathe tool, mounted in the lathe tool post, and operated by the lathe feed in the usual manner. At each forward movement of the crosshead the tool cuts about five eighths of the distance around the pin, and when one side of the pin is turned the crosshead is reversed in the lathe, and the opposite side turned, completing the pin. It is not necessary to remove the back gear of the lathe to attach this device, consequently the operator can use any desired speed. This attachment is patented, and is made by the Bay State Iron Works, Erie, Pa.

(258) J. D, Jersey City, N. J., asks: What is a vacuum? *A.*—It is an empty space in which there is neither water nor air, nor anything else that we know of. 2. What is a vacuum used for on ferry-boat engines? *A.*—A vacuum (or more correctly speaking, a partial vacuum, because a perfect vacuum cannot be obtained in a steam engine) is maintained in all condensing engines for the purpose of reducing the back pressure to below the atmospheric pressure on the piston, thereby allowing the steam which impels the piston to do more useful work, or in other words, increase the power of the engine. In non condensing engines the back pressure on the piston is greater than the atmospheric pressure, consequently the steam which impels the piston has to overcome a greater resistance than there is in a condensing engine, and the power of the non condensing engine will be proportionately decreased. This shows to some extent the advantage of the partial vacuum maintained in condensing engines, to which type ferry-boat engines belong. 3. What book explains the meaning of vacuum in very plain language? *A.*—"The Catechism of the Steam Engine," by J. Bourne, will probably suit your purpose best. In regard to your questions relating to problems in arithmetic and mensuration, you will find the information you seek in Greenleaf's "Complete Arithmetic." Study this book thoroughly before you attempt to solve problems in steam engineering. 4. How can I find the horse power of a steam engine? *A.*—See answer to Question 156 in our issue of March 30, 1893, but it will be useless for you to attempt to solve problems of this kind unless you are familiar with elementary arithmetic.

(259) F. W., New York, writes: I would like to know how I can obtain some reliable information in regard to the brake system used on the New York elevated road and the New York Central Railroad. Any description or an indication of the principle upon which these brakes work which you may give will be appreciated. *A.*—On the elevated roads in this city, the Eames automatic vacuum brake is used. It consists of an ejector, placed upon the engine, and a reservoir, automatic valve, and two brake diaphragms under each car. A vacuum is maintained in the train pipe and reservoir by the ejector, and the brakes are applied when this vacuum is reduced in the train pipe either by the engineer or by the parting of the train. On the New York Central Railroad, the Westinghouse automatic brake is used. It consists of the following essential parts: The steam engine and pump, which produce the compressed air, the supply of steam being regulated by the pump governor; the main reservoir in which the compressed air is stored; the engineer's brake valve, which regulates the flow of air from the main reservoir into the brake pipe for releasing the brakes, and from the brake pipe to the atmosphere for applying the brakes; the main brake pipe, which leads from the main reservoir to the engineer's brake valve, and thence along the train, supplying the apparatus on each car with air; the auxiliary reservoir, which takes a supply of air from the main reservoir, through the brake pipe, and stores it for use on its own car; the brake cylinder, which has its piston rod attached to the brake levers in such a manner that, when the piston is forced out by air pressure, the brakes are applied; the triple valve, which connects the brake pipe to the auxiliary reservoir, and connects the latter to the brake cylinder, and is operated by a sudden variation of pressure in the brake pipe, (first) so as to admit air from the auxiliary reservoir to the brake cylinder, which applies the brakes, at the same time cutting off the communication from the brake pipe to the auxiliary reservoir, or (second) to restore the supply from the brake pipe to the auxiliary reservoir, at the same time letting the air in the brake cylinder escape, which releases the brakes. For fuller information and construction of details we should advise you to send for catalogues to Eames Vacuum Brake Company, Watertown, N. Y., and to the Westinghouse Air Brake Company, Pittsburgh, Pa.

(260) W. W., Buda, Ill., writes: The inclosed sketch represents the arrangement for a hand car wheel brake. The brake shoes are of wood. One of the shoes for a pair of wheels is set ¼ inch in advance of the other when the truck leaves the shop. The shoe furthest from the wheel has a step upon which the pressure is applied in putting the brake into action, part of this pressure is transmitted to the other shoe by means of a gas pipe which connects the two shoes, and which revolves in bearings. I claim that in time the advancement of one shoe will cut no figure, and that both will wear, so that one shoe will touch the wheel as soon as the other, and that the most pressure will be on the shoe to which the step is applied, and that the one inch pipe will not transmit a pressure to the opposite shoe equal to the pressure of the one with the step. I claim that in order to give equal pressures on both shoes the force should be applied at or near the center of the pipe. Our superintendent claims that in advancing one shoe ahead of the other (I mean by setting one shoe so that when it touches the wheel the other with the step on it will be ¼ inch off) the wear will always be the same, and that the same conditions will exist in a year's wear as when first leaving the shop. Also, that the pipe will cut no figure, and that the same pressure will be on both shoes. *A.*—You are correct in saying that for equal pressures on both shoes the force should be applied at the center of the pipe. The amount of wear on each shoe will depend much on the intensity of the force applied on the step, and the elasticity of the pipe which connects the two shoes. The pressure on the step can be so light that only the shoe opposite to the one to which the force is applied will touch the wheel and be subject to wear; under these conditions the original difference between the distances of the shoes from the wheels will be decreased in time. On the other hand, the pressure on the step can be so great that the shoe attached to the step will wear faster than the opposite one, thereby increasing the original distances between the shoes and the wheels The whole matter can be summed up as follows: When the force is applied to the step attached to one shoe the pressure on the shoes may or may not be equal, it all depends on the manner in which the brake is handled, and consequently the relative distance between the shoes and wheels may or may not change, the probability is that it will change. If the force is applied to the center of the pipe, the pressures on the shoes will be equal, provided both are set at the same distance from the wheels, and the wear will also be equal.

(261) A. B, Brooksville, Fla., writes: Please inform me how I can find by measurement when my engine is on the dead center. Also how I can find the position of the eccentric when the engine is on a dead center. *A.*—On the crank disk or fly-wheel describe an arc *a r*, as shown in the accompanying sketch; if the periphery of the disk is turned, this arc can be described with the aid of a gauge; if the periphery is not turned, then the arc should be described with the aid of a scriber or sharp pointed instrument held against the face of the disk, while the shaft is revolving in its bearings; but which ever way the arc is described it must be true. Turn the shaft in the direction of the arrow, until the crosshead is within a short distance from the end of its stroke, say, ½ inch; while in this position mark on the slides and crosshead a line *g g*. From any fixed point *j*, on the floor, for instance, and with a tram of any convenient length describe a short arc intersecting the arc *a r* in the point *b*. Now turn the crank



in the same direction as before, causing the crosshead to complete its full stroke and part the return stroke, until the lines *g g* on the crosshead and slides are exactly fair, then stop turning the shaft, and describe from the point *j*, and with the same tram as before, a short arc intersecting the arc *a r* in the point *c*. Find the point *h* on the arc *b c*, midway between the points *b* and *c*. Now turning the shaft into a position in which the ends of tram will touch the points *h* and *j*, the crank will then be on one of its dead centers. The opposite dead center is found in a similar way. To locate the eccentric and valve proceed as follows: Locate the eccentric by the eye as near as may be, and ahead of its correct position rather than behind it. Bring the engine to either center as found above, turning it in doing so in the direction of the proposed rotation in order to neutralize any looseness in the connections. With the engine on the center, locate the valve to give the required lead, after which turn the engine in the direction of its future rotation to the opposite center. If the center is ahead of its correct position, the lead for this position will be greater than the first; if the eccentric is behind, the second lead will be less than the first and probably negative. In either case the valve is to be adjusted on the rod to divide the difference in the lead. This being done, the valve is correctly located on the rod, the lead is equal at the two ends of the cylinder, but is too large or too small at both. To correct this it only remains to adjust the eccentric, moving it in the direction of rotation until the valve has the proper lead. Verify the results and the work is done. It seems to us that the book entitled "Slide Valve Gears," by F. A. Halsey, will be of great aid to you. It gives an explanation of the action and construction of plain and cut-off slide valves.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Grant's Gears, Lex'n, Mass., & Phila, Pa. See p. 12.

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Milling Machs. Kempsmith M. T. Co., Mill., Wis.

Turret Drills, 6 spindles. A. D. Quint, Hartford, Ct.

"National" Lathe Chucks. Best made, page 15.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 157 William St., N. Y.

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Best Presses and Dies for all sheet metal work. Ferracute Machine Company, Bridgeton, N. J.

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Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

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Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

"Pumping Machinery." New book, 450 pp. 8vo, 270 Eng. Prospectus free. W. M. Barr, 3223 Powelton avenue, Philadelphia, Pa.

New Jersey Art Metal Co., Passaic, N. J., finest thin and ornamental castings in brass, bronze, aluminum, etc.; machinery name plates in brass and aluminum.

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"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid. Published by John Wiley & Sons, 53 East Tenth street, New York.

Water-tube Boilers—II.*

Ex-Chief Engineer Isherwood, U. S. Navy, said: The merits of the water-tube boiler have been very clearly stated in the paper just read by the secretary, and its principal merit, of course, is the lighter weight. The vital defect about it, one which has been very little alluded to heretofore, if known at all, is that it is impossible to obtain with it the same economic evaporation that you can obtain with the ordinary shell boiler. That is to say, if you make the two boilers, the pipe boiler and the shell boiler, both with the same grate surface, and the same heating surface and burn the same quantity of coal in both per unit of time, it will be found that the pipe boiler gives about ten per cent. less economic evaporation. That is to say, if one boiler will evaporate 10 pounds of water to the pound of coal, the other will evaporate but 9 pounds Of course, there is a reason for this, and I think it is very easy to see. It arises from the air leakage in the case of the water tube boiler. In the case of the shell boiler, no exterior air can mingle with the gases of combustion. The only air that enters is what enters through the furnace, in the ashpit and over the bed of coal on the grate, through the holes in the furnace door. Every particle of air that enters into and mingles with the gases of combustion after they have passed over the bridge wall reduces the economic evaporation of the boiler very largely. In the first place, it cools those gases so that they cannot give the evaporation, and in the second place, it requires a certain quantity of heat to force those gases out against the resistance of the atmosphere, which also is at the expense of the heat of the coal. The two things put together will make that difference about ten per cent., as I have stated. There is no practical way of excluding the air leakage,

*Conclusion of discussion of the subject at meeting of Mechanical Engineers in New York, May 9th.

and while I am on this subject, I will say that there is just the same difference of 10 per cent. in boilers set in brick-work. You take the ordinary boiler with straight tubes and the shell, and you set it in brick work. You have a brick furnace. You will never get the same economic evaporation from it as with a shell boiler, that is, the Scotch form of boiler, for the simple reason that there will percolate through the brick-work setting a certain quantity of air (very much larger than any one would suspect), and that reduces the economy of the evaporation. In the early days of my practice as an engineer, I was confronted with the fact that all the boilers set in brick masonry gave a lower economic evaporation than those not so set. In other words, that the interior fired boiler gave a higher evaporation than the exterior fired boiler. I made quite a table of the results from all the boilers of the two types that I could obtain. A very great many of those experiments were made by me, and taking the mean of them, I found that they approached the 10 per cent. very closely. I did not at that time know the reason. I thought it was something in the type of boiler. But really I could not reconcile it. I had the same grate surface, heating surface and combustion of coal in both cases. I could not see why this difference should be for a long while. But the difference was there as a practical fact, and it was caused, as I afterwards ascertained, by what I have stated—the in-leakage of air into the gases of combustion, cooling them and requiring more expenditure of heat to expel them from the chimney.

Now, let us see what in a ship a difference of 10 per cent. in the evaporation of the boiler means. It means a good deal more than what appears on the surface. To develop the same power for the same length of time you have got to carry 10 per cent. more coal in your bunkers. If you have a vessel that carries a thousand tons of coal in its bunkers it has got to carry 1,100 tons if you replace the shell boiler with the pipe boiler. Now, that difference of 10 per cent., of course, becomes more important as you carry more and more coal and make longer and longer voyages. That difference goes very far to counterbalance the saving of weight with the water tube boiler Of course, upon the land where the weight is of no importance you simply lose your 10 per cent. of fuel. But on a ship you not only lose that but you have got to carry this extra weight, and if you do not carry it you have reduced the steaming efficiency of your vessel that much. . .

For small vessels, launches, torpedo boats and that class of vessels, you have generally but one boiler and you have plenty of air circulation around it, where it can be kept clean and well cared for. If any repairs are to be made it can be hoisted out by a few men on the dock and put back again. But it is a very different thing when you put an enormous power into a vessel and boilers of this type. As a general rule they will probably last under ordinary circumstances of sea practice from two to three years. It is difficult to understand that they can last longer than that. I am aware that some boilers like the "Cushing's" and a few others have lasted much longer, but why? They have been protected by zinc. Large quantities of zinc have been put into them according to the practice of the Thorneycroft people and others building those boilers. That answers very well. But it is very expensive. The simple question is, Will you pay in zinc or will you pay in boiler? But you have got to pay for the thing one way or the other. In the case of a water-tube boiler with its thin outside casing of sheet-iron, apart from the great loss of heat by radiation there comes the difficulty of repairing. Any person who has examined those boilers and has seen the wilderness of small tubes in them, the impossibility of getting at any one of them or at their joints, will see that to repair one of those boilers you have got to lift it out as a general rule. You cannot find the place. It may happen to be a double tube or an inside tube and you can see it, but if it is any of the interior tubes that leaks it is impossible to tell. Now, in the case of a vessel that is a very serious piece of business to have your boilers break down all at once at sea. What is required is durability. That is a very important point In the case of the ordinary Scotch boiler, in which iron tubes or steel tubes will last from two to three years, you can always see when your tubes are going. It is only a matter of eye sight and they are easily replaced They are a straight tube. Your firemen can replace them with very little trouble. But it is a very difficult thing in a water tube boiler in a large vessel, where you have to break all the connections, piping, everything, and actually lift the whole affair out, amounting to almost a reconstruction, each time you attempt to make extensive repairs. Of course, these are facts which will probably develop as these boilers come more and more into use, and I have no doubt they will come into use, but not permanently. I have very great doubts of that for anything like seagoing vessels. But like all other physical subjects we must depend on practice and experience to decide. The tubes of an ordinary tubular shell boiler will last from two to three years, and there is no imaginable reason why they should last any longer in the water tube boiler, if as long. The old Martin boilers which we had in the Navy had vertical water tubes placed in the tube box. When those tubes were made of iron the lower six to nine inches began to rust out in less than a year. You had to commence renewal at about that time and continue it constantly until they were all renewed. The upper part of the tube was not touched. They were as good as new. The lower part was entirely gone. Now, why was it? Simply this: the lower portion of the tubes was in ashes, the ashes from the coal deposited in that, and every time the boilers were cooled down there was a deposit of moisture on the surface of the tubes which trickled down into this ash and made an alkaline solution which corroded the tubes very rapidly. Now, why should not this result take place in, we will say, the Thorneycroft boilers in which the lower parts of the tubes are vertical? They are inaccessible for cleaning; the ash and soot must collect and they must be damp at times, and there must be the same alkaline solution there that there was in the Martin boiler, only much more so, and why should it not produce the same effect of eating out the tubes?

These are all matters which future experience will have to solve, but they are very important ones and lead us not to be too sanguine on the success of the new class of boilers.

With regard to the Belleville boiler, that was first used in the French Navy as far back as the days of Napoleon III. It was put, I think, in some half a dozen vessels, and I do not know that that type of boiler has been modified at all since—that which was put in the "Shearwater" was exactly the same as used in the earlier French vessels, and every one of them was taken out. A number of years ago I was in France and visited every French dock yard, and I conversed very freely with the French engineers stationed there. Their opinions to a man were against that type of boiler. They were all removed from the vessels. Since that they have been re-introduced, and with what success it is impossible for me to say, because the most instructive of such trials rarely are made public I mean the failures. We hear all about the successes, but we hear nothing of the failures, and that is one of the great difficulties we have in engineering, in getting at the correct state of facts. Nevertheless, I think that the Navy should make large experiments on this type of boiler; build one of that type, try it thoroughly, stop at no expense on it, because the subject is well worthy the cost. But thus far we have not had any such experiments, at least not complete enough or expensive enough to enable us to form a real opinion upon it.

As regards the forcing of that type of boiler it can be forced to any extent, from the simple fact that the tubes are curved so that any difference of expansion does not injure the joints, but the tube merely curves more or straightens more, but the joint remains unaffected, nor is the tube at all injured. In the vertical Scotch boiler we have a straight rigid tube, and whenever the temperature of that tube becomes much greater than the temperature of the water which surrounds it, it is sure to expand and force the tube ends through the tube plates. That has always been the result when the attempt is made to force combustion in a vertical Scotch boiler beyond 46 or 47 pounds of coal per square foot of grate per hour. That is the maximum combustion that is possible with it.

In the British Navy the attempt was made to go beyond that, and, as all the world knows, it was a failure. The boilers leaked a deluge the moment that rate of combustion was passed. Then it was stated that by means of a species of ferrules they succeeded in overcoming that difficulty. Well, that was one of the little romances that are sometimes used to cover a failure. The truth is the so called ferrules did no good whatever, and the proof of it was the fact that they were obliged to lessen the rate of combustion down to a point somewhere in the neighborhood of 40 to 45 pounds, which is now the maximum, and at which those boilers are perfectly safe, but not above that.

Now, these are about all the facts we have to go on, and what we want now are careful experiments made by competent people here in America where we know the persons and can witness the processes. The subject is a very important one, indeed, and I would be the last one to throw cold water upon it. Still, I think, the chances of ultimate success are much better when all the difficulties are known in advance, and can be calmly and deliberately provided against.

Mr. Eckley B. Coxe: I wanted to ask whether anybody knows what effect increasing or decreasing the amount of coal consumed per square foot of grate surface has on the relation of the temperature of escaping gases, and secondly, upon the relation of the carbonic oxide and the free oxygen. From experiments I have made lately, I am satisfied that a great many of the wonderful divergences that are found in experiments on boilers are due to the fact that the relation between the free oxygen and the carbonic acid and carbonic oxide varies very considerably. I have recently, in an experiment, had as high as 15 per cent. carbonic acid and no carbonic oxide. I have also had as much as about 9 carbonic acid and 8 of free oxygen, and still nearly 2 per cent. of carbonic oxide. Now, it is not necessary to tell anybody that that will account for a good deal of difference in evaporation. The reason that I ask the question is that I cannot find much about the subject anywhere, and I would like to know about it. The question with me is this: When you are burning 30, 35 or 40 [pounds of coal per square foot of grate], and you force that up to 45 or 50, how does the relation between the CO, the CO_2, and the free oxygen change?

Mr. Isherwood: I think I can answer the question in part. The relation of the different gases of combustion depends altogether on the thickness of the bed of coal upon the grate surface. If the thickness of the bed of coal is not more than 12 inches, nor less than 6 inches, it will be found that there is practically a perfect combustion with coal of the ordinary lump size, and that just twice the quantity of oxygen or atmospheric air has been supplied that is chemically required. Now, if you simply increase the depth of the coal on the grate bars, you can have any proportion between carbonic acid, carbonic oxide, unconsumed air, and free oxygen that you like. The temperature of combustion is entirely independent of its rapidity. The temperature of all coal fires at the surface of the coal is exactly the same, and you will have perfect combustion if you will keep within those limits of thickness. Good firing consists in knowing what those limits are, and keeping within them. Some particular fireman, or some particular watch of firemen, do a great deal better than others; they carry the same steam with very much less fuel. They have found out by practice the exact thickness of the bed of coal that gives them the maximum result, and they adhere to that. Other firemen, less observing, do not know that, and violate the rule, and, of course, make a great deal of carbonic oxide, and lose a great deal of the economic effect. But the whole question is simply one of thickness of coal on the grate bars. By varying that you can obtain just any ratio of those gases among themselves that you desire.

Mr. James McBride here gave some analyses of flue gases made by burning log wood chips, and coal. His figures and experience sustained the position of Mr. Lidgerwood. He said:

I use the Elliott gas testing apparatus, and I make analyses of the gases every few days. I find, when the boilers are not making steam as they ought, by an analysis of the gases, a large amount of carbonic oxide going to loss, and not sufficient oxygen. I can regulate it very nicely by increasing or decreasing the amount of fuel burned, and by regulating the air.

Mr. Forney: I should like to inquire if any one present has any data with reference to the water capacity of water-tube boilers in proportion to the quantity of fuel consumed. It has seemed to me from the general drift of the papers on this subject that some difficulty in the operation of water-tube boilers was experienced from the fact that the water capacity of the boiler was so extremely small in proportion to the old-fashioned shell boiler, and that naturally led me backward to the experience in locomotives, which, as you know, years ago were of small dimensions, and as traffic and business increased, the demands upon the locomotives increased in somewhat like proportions, but the size of the boilers, unfortunately, did not. Now, I think it has been proved a great many times in locomotive practice that the increased water capacity is a decided advantage in the operation of the locomotive and the boiler. I may relate a little experience which has already been in print that may be new to most of you that I had some years ago with some engines built for a Western railroad, and which had what we called straight-top boilers, that is, there was no wagon top for steam space, and the boilers were of comparatively small diameter. Those engines were put to work and gave considerable trouble. They would not make steam and they did not do their duty properly. Finally a trial was made of those engines with some others which had boilers of a larger diameter and wagon tops of considerable height to give steam room, and they were run in competition, taking alternate trains every other day. The result was that the straight-topped boiler was very badly beaten. The method of operating it was this: the large boilers having a large water capacity and plenty of steam room, on approaching a heavy grade were pumped as full as it was possible to carry the water without working it through the cylinders. The result was that in coming to a difficult place in the grade the engineer could shut off or partly shut off his water supply, and work up the hot water which was stored up in the boiler to a certain extent. This gave him a reserve power that he could fall back upon. Of course, I am aware that marine engines and boilers are not called upon to work under as many different degrees of power, I may say, as locomotives, but at the same time it seems to me that a large water capacity must be a matter of considerable importance even in marine boilers, and inasmuch as the water capacity of water-tube boilers is very much less than of cylinder boilers, that that must be a matter worthy of attention. I may add that I have in my hand a letter which I have received from Mr. Hazelhurst, superintendent of machinery of the Baltimore & Ohio R. R., in which he gives me the water capacity of an engine on that road.

Mr. Forney here read the letter as follows:

It gives me great pleasure to furnish you the information as to the water capacity of engine 937, which is the one that we tested on the 17 mile grade, burning some 192 pounds of coal to the square foot of grate per hour. The results given are actual results and are not calculated, the engine being weighed with the water at the different gauges, and when full.

Capacity of cold water in boiler:

	Pounds.	Cubic Feet.
Full to whistle	14,400	230 93
Fourth gauge	11,100	178 01
Third gauge	10,400	166.78
Second gauge	10,050	161.17
First gauge	9,200	147 54
Steam space with three gauges of water		64.15

The outside diameter of boiler at smallest ring is 54 inches; height of wagon top, 8 inches, and square feet of grate surface, 28.33.

MR. MOSHER: The bad reputation that a great many water tube boilers have, I think, is due to their not being adapted to the work intended. Take an ordinary cylinder boiler, or even an ordinary kettle on a stove; if not forced too hard it gives very satisfactory results. If you attempt to drive it very hard, you then have to provide some further means for circulation, or you drive the water all out of it. Now, as regards the economy in a boiler, the first place to look is in the fire. The amount of coal that can be burned is governed by the draught as well as the cooling effect surrounding that fire, which last has some little importance in many cases. If the conditions are such as to admit of perfect, or nearly perfect combustion, it matters not what sort of boiler you use, provided you supply sufficient heating surface to absorb the heat, so that the temperature admitted to the stack is very low. Now, the amount of draught in many cases is dependent on the temperature released in the stack, which governs the amount of coal burned, and also governs the economy of burning that coal. . . .

Mr C. E. Emery here discussed the principles of circulation in boilers, and the different methods by which circulation was brought about, and after some further discussion on relative durability of water and fire tubes, etc., Mr. Forney, before adjournment, said:

As announced in the notice of this meeting, this is the last one of the series of meetings held for the discussion of topical subjects, and with these meetings the duties of the committee end. Whether the meetings will be continued in the coming fall and winter or not will remain for the members of the society to determine. The experiment has been undertaken by some of us to find out if we could whether such meetings as these would be successful. I think it may fairly be claimed that at least a moderate degree of interest has attended them, and that they have received a sufficient amount of encouragement to continue them hereafter. When they were first started there were members of the association who exercised a considerable amount of ingenuity in finding reasons to show why such meetings could not succeed; whether those reasons were well grounded or not the past experience will have to be the answer. Some opposition was also made from the fact that it was thought that the non resident members would complain that the resident members had advantages in these meetings which those people who live out of town had not, and that that might result in some feeling of jealousy, and the precedent was cited that in the Society of Civil Engineers some difficulty of that kind had been found, and considerable feeling had grown up. It seems to me that it is hardly fair to attribute such a feeling as that to the non resident members. I can hardly believe that any such dog in the-manger feeling can have any considerable existence in the membership outside of New York. At any rate, there can be no sound reason why half a dozen members of the society, or a dozen, or a hundred members may not meet together in this room for the discussion of subjects which are mutually interesting. The same thing is true of the people who live elsewhere. The members in Boston have that same privilege. The members in Chicago can do the same thing. I may relate a little experience I had in a railroad association (the Master Car Builders' Association), which has had an existence of some 20 or 25 years, and probably some 15 years ago a local society was organized in this city, which was really an offshoot of the parent association, and those meetings have been held now, I think, for 15 years. Since then similar local organizations have been formed in Boston, in Buffalo, and in Chicago, and instead of their detracting from the interest or the value of the parent association, which holds its meetings only once a year, I think it was universally acknowledged that the local meetings had helped to increase the interest in the parent association; that it results in the discussion of subjects which come up before the annual meeting, and that men come to the annual meeting with a supply of information on those subjects that they would not otherwise have. It is not plain to me why these same results would not occur to mechanical engineers. If meetings of this kind could be established in Boston and other cities, wherever there was a sufficient number to form a local assemblage, the result would be that the members would have a greater interest in the association in New York than they would have if such meetings are not held. I therefore think that these meetings should be continued, and that some permanent committee should be established to take charge of them.

Upon motion of Mr. McBride a vote of thanks was given the committee.

An Improvement in Cable driving Machinery—I.

BY M W. SEWALL.

It was my good fortune to be associated with Major Geo. W. McNulty, chief engineer of the Broadway and Seventh Avenue Railroad in New York, and Mr. H. Waller Brinkerhoff, his principal assistant in road construction, as engineer in charge of the designs for the cable-driving plants for that road.

When the writer first took the matter up it had been already determined by Major McNulty to drive the cable machinery by rope transmission. This means of transfer of power from the engine shaft to the shafts of the cable driving machinery was preferred because the principal power station, which was to be located at Broadway and Houston street, was to be situated in the basement of a large business building, and the usual tremor that accompanies the use of toothed gearing would be inadmissible in a building to be rented for stores and offices.

The conditions to be met in the design of this plant were as follows: Cars were to be run on the busiest street in the city of New York at 40 seconds headway, and a stoppage of the railroad service not only greatly incommodes the traveling public, but causes a congestion of general traffic which is very detrimental to all concerned, and should it occur with any frequency would prejudice the public against the road and its management. Every effort, consequently, must be made to keep up a continuous service for the whole 24 hours of the day.

To accomplish this end duplicate sets of machinery were determined upon, and two cables were to be laid in the conduit, each to be independent of the other in all respects, so that both could, if desirable, be operated at the same time. Under these conditions it is necessary to clear the way only before starting the second cable after any accident that may occur on the road or in the conduit.

It is also, of course, desirable to be able to run the cable of one half of the plant by the engine of the other half if the first be disabled. Thus giving four different combinations for operation, which is the maximum number for two single plants as usually constructed, but as will be shown later, several other combinations are possible here.

When studying the Brooklyn Bridge plant, as designed by Mr. Leverich, I saw that the system of hollow shafts for the driven drums enveloping shafts in torsion only for the driving parts, could be expanded into a very flexible system, having many advantages in the way of repairs and ease of handling. It was therefore determined to proceed on those lines with both the Fifty first street and Houston street plants.

The entire exclusion of other than torsional stresses in the shafting enabled the diameters to be kept at a minimum. The cable to be driven was 1½ inches diameter, and the largest shaft necessary in either plant was found to be only 13½ inches diameter.

The hollow shafts were large without regard to their strength, as they were cored to pass over the central shafts. The former were cored several inches in diameter in excess of the latter, except at the ends where they were bored and only one-half inch larger.

The transmission of power from the engine shaft to the driving machinery proper was to be, as has been said, by ropes; 2-inch cotton ropes were determined upon, to be arranged after the English system, that is, several separate endless ropes are used running on multiple-grooved pulleys. A rope drive requires high velocities to be effective, but the diameter of drums becomes excessive in such a plant as this, consequently the number of ropes required is large. With cable drums 12 feet in diameter, and an engine shaft making 60 revolutions per minute with a 10-foot diameter rope pinion, the rope drum on the cable drum shaft will be 32 feet diameter. This gives only 1,877 feet per minute for the speed of the cotton ropes to run the cable eight miles per hour. This is slow for driving ropes of this character; a speed of 4,000 to 5,000 feet per minute can be used with greater economy.

The detailed description will be confined to the Fifty first street plant, as that plant drives but two cables 12,000 feet in length extending from Thirty sixth street to Central Park. While the Houston street plant drives four cables, two extending from the station north to Thirty-sixth street, and two south to and around Bowling Green. Each of these four cables is about 19,000 feet in length. The plan of one-half of the Houston street plant is shown on sheet 1 *A*, as the drawing shows more clearly the parts than Fig. 1.

A 1½ inch steel cable has a working tensile strength of 22,000 pounds, and a breaking stress of 110,000 pounds. The winding machinery is designed to be able to put a maximum stress of 60,000 pounds into the cable as a direct pull, thus insuring ample strength and stiffness in all its parts.

The normal pull on the cotton ropes driving one cable is $32 : 22{,}000 :: 12 : x = 8{,}250$ pounds direct pull.

Professor Unwin gives the driving force of a $2\frac{1}{16}$ inch diameter rope as 330 pounds. We have, however, taken it considerably lower than this—242.6 pounds for a 2 inch rope—as we assume that a higher stress may be brought upon the cable than the normal. We have not, however, reduced the driving force in the calculation so low that the maximum stress of 60,000 pounds on the cable would not strain the ropes to more than 330 pounds.

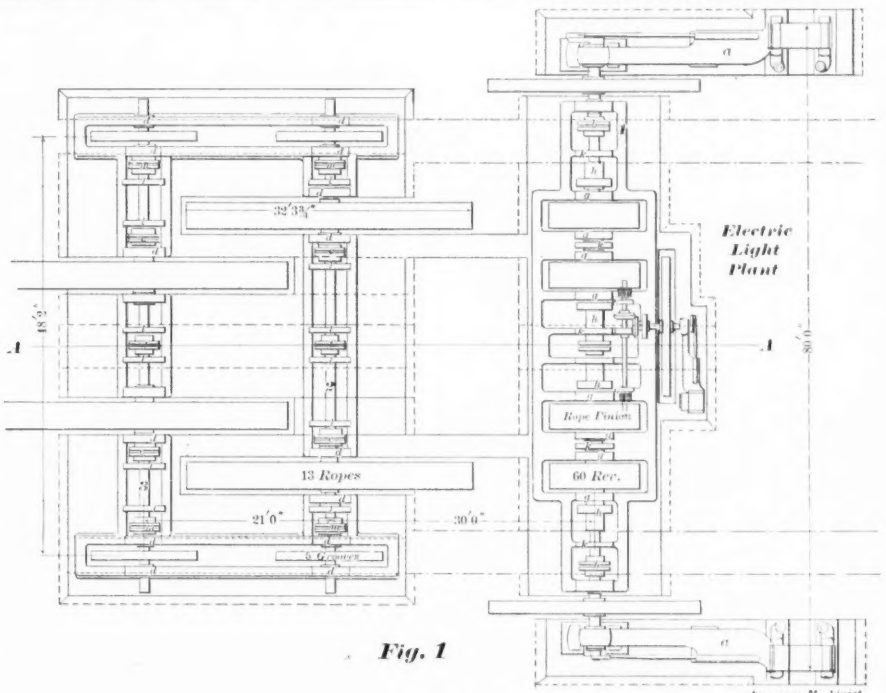


Fig. 1

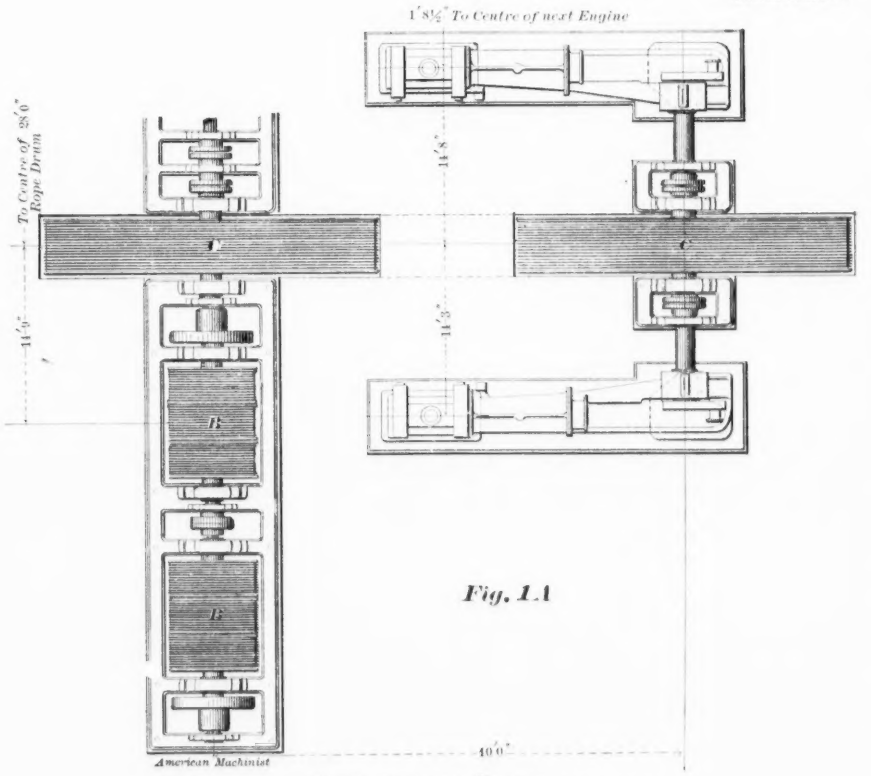


Fig. 1A

CABLE DRIVING PLANT.

The maximum cable stress is 2.7 times the working stress, and the maximum stress on the cotton ropes is permitted to become twice the working stress allowed by Professor Unwin for a $2\frac{1}{16}$ inch rope, or 660 pounds. This, however, is for a $2\frac{1}{16}$-inch rope, and our rope being only 2 inches diameter the maximum stress will run a little above twice the allowed working stress—8,250 direct pull ÷ 242.6 pounds per rope = 34 ropes for driving one cable to its working stress of 22,000 pounds.

The cables have three wraps on the 12-foot drums (the drums are arranged for four), which drums are 21 feet center to center; each drum shaft would be driven by 17 of the 2 inch ropes running on drums with 17 grooves. This length of cable being short, however, it was considered that 13 ropes on each shaft would be sufficient, equal 26 for driving the cable, face of drums 3 feet $1\frac{1}{2}$ inches. By referring to Fig. 1, the general arrangement of the plant is shown in plan; from the plan it is seen that the plant is symmetrically arranged on either side of a center line *A A* at right angles to the shafts and midway between the engines.

It may be seen also that this line divides it into two separate plants, which may be coupled into one by the connection of the plate couplings *f*. These would preferably be friction clutches.

The cable drums are carried by short shafts extending through the inboard pillow blocks only far enough to attach the couplings *m*. The shafts, 2 and 3, extend to the central couplings *f*, by which they may be connected. The 32-foot rope drums are carried by the hollow shafts already mentioned, and are supported in the pillow blocks *d*. The cable drum shafts are supported in special pillow blocks *d*, with caps placed at an angle to allow for the pull of the horizontal wraps of the cable. The bearings of the shafts 2 and 3 are shown at *b*.

The 32-foot rope drums and cable drums turn 18.66 revolutions per minute, and the engine shaft No. 1 turns 60 revolutions per minute.

The 10-foot diameter rope pinions mentioned previously are supported on hollow shafts with independent bearings in the same manner as are the 32 foot drums. The pinions have their connection with the main shaft (No. 1) through friction clutches *h*, while the 32-foot drums are connected by plate couplings *e*. Preferably these would be friction clutches also, as greater flexibility to the plant would result. It was thought, however, when the designs were made that it would be a refinement that would not be warranted. Shaft 1 is cut just outside of the engine pillow blocks and couplings inserted. These also, I think, should be friction clutches. I should not in these cases use a Weston plate clutch, as without special precautions they are liable not to free themselves completely, and so absorb much power by their friction when running open. The advantages in the large use of clutches may be seen by the following combinations that may be made in running with them:

1st. Each plant may drive its own cable, which is the normal condition of running.

2d. The left engine may drive the right cable, and *vice versa*. This change of engines may be done without stopping the cable with friction clutches, while with plate couplings it must be stopped probably for a half hour to make the transfer.

3d. The left engine may by the left set of rope gear drive the right-hand cable, and *vice versa*.

4th. The left engine may by the right set of rope gear drive the left cable, and *vice versa*.

By using friction clutches for connecting the right and left plants, any of these eight changes may be made without stopping the cable, except, of course, when the cables themselves are changed. They may all be made by the use of plate couplings, as shown in Fig. 1, but time for the changes is necessary, and continuance of traffic is the vital point with such a plant.

MANUFACTURES.

An electric-lighting plant will be erected at Trappe, Md.

A municipal electric-light plant will be erected at Cuthbert, Ga.

An electric-lighting plant will probably be established at Greenville, N. C.

The Minneapolis Smokeless Furnace Company, of Minneapolis, will manufacture the Nonpareil smoke device.

The Camden (Ark.) Foundry and Machine Co. will erect a foundry.

The Roaks Cabinet Co., of Centralia, Ill., has been organized; capital, $20,000.

Mast, Kalback & Spangler will rebuild their burned saw-mill at Poplar Bluff, Mo.

The Round Mountain (Ala.) Furnace Co. will operate the Elliot Pig-iron Co.'s furnace.

A foundry and machine shop has been established at Westpoint, Miss., by Whipple & Bell.

The Columbia (Pa.) Rolling-mill has resumed work with 200 hands after some months' idleness.

The Improved Sewing Machine Needle Co., of Milwaukee, Wis., has been chartered; capital, $250,000.

The Imperial Electric Lamp Co., of New York, has been formed; capital, $250,000, and directors, J. F. Wood and others.

The American Steel Foundry Co., of Granite City, Ill., capital, $300,000, is organized to manufacture steel castings.

The Queen City Radiator Co., of Buffalo, has been organized, with capital $300,000; directors, W. F. Bryant and others.

The Watts Steel and Iron Syndicate, Middleborough, Ky., expects to put its furnaces in operation by the 10th of June.

The World Manufacturing Co., Columbus, O., has been incorporated; capital, $100,000. It will do foundry and machinery work.

The Belknap Motor Company, Portland, Me., have begun work on an extension of their works at the corner of Fore and Cross streets.

At a recent meeting of the directors of the United States Watch Co., it was decided to continue to run the factory at Waltham, Mass.

A stock company is being organized at Holyoke, Mass., by O. E Genest and others, to build a newly invented leather-measuring machine.

The Casey Nailing Machine Co. has been formed to make machinery in Lewiston, Me. Capital, $100,000, and directors, J. Casey and G. Dougherty.

The Harris Automatic Air-brake Coupler Co., Spartanburg, S. C., has been formed to manufacture an air brake and car coupler. The capital stock, $1,000,000.

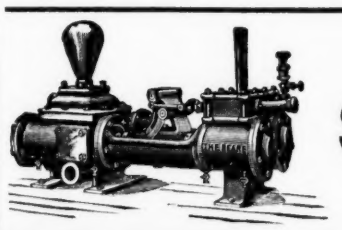
Wallace & Sons, of Ansonia, Conn., are finding business better, and are running some departments of their works 14 hours a day. They have also increased their force.

The Billings & Spencer Co. have changed the location of their Chicago office from 59 So. Canal to No. 17 So. Canal street, thereby attaining more commodious quarters.

The Bath Iron Works recently shipped a steam windlass and engine to Toledo, O., for a whaleback steamer building by the Craig Shipbuilding Company of that city.

At a meeting of the Electric Light Company, Marblehead, Mass., it was voted to purchase the Redstone Cove property, and to erect the proposed electric-light plant thereon.

Exchanges state that the implement manufacturers of Moline, Ill., are talking of erecting a rolling-mill there to supply the several establish-



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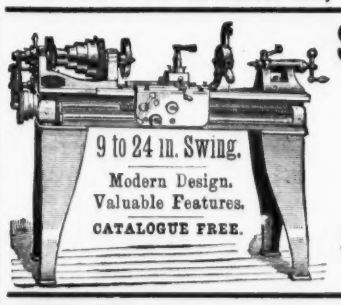

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ments with material now purchased from mills at a distance.

F. E. & J. M. Church, Angelica, N. Y., are adding to their steam capacity by putting in a 80 horse-power steel boiler that will stand a working pressure of 150 pounds. McEwen Bros., of Wellsville, N. Y., are the builders.

At Birmingham, Ala., the Commercial Club has a plan afoot for the organization of a co-operative company to buy and operate the Avondale Rolling Mill, and the required amount of capital, $25,000, will probably be secured.

We have received from Alfred Herbert, Coventry, England, "section B" of his catalogue, which is devoted to the illustration and description of an improved universal cutter grinder, which is adapted especially for grinding all kinds of milling cutters.

The Portland Electric Works have been organized at Portland, Me., for the purpose of manufacturing and dealing in electrical apparatus and supplies, with $50,000 capital stock. The officers are Nathan A. Redlon, of Portland, president; Charles O. Files, of Portland, treasurer.

We have received from Peter A. Frasse & Co., 95-97 Fulton street, N. Y., a catalogue of specialties in shop equipments. This is devoted to the illustration and description of many of the small tools and appliances which are used about the machine shop, and is sent upon application.

We have received a catalogue of emery wheels and machinery for using them, issued by J. Wendell Cole, M. E., of Columbus, O. The catalogue contains illustrations of a variety of grinding machinery and considerable information of value regarding grinding processes. It is sent upon application.

We have received from E. G. Smith, Columbia, Pa., a catalogue and price list of "Modern Measuring Instruments." The catalogue contains illustrations of the various forms of slide gauges and calipers manufactured by Mr. Smith, and which have been illustrated in our columns from time to time. It is sent upon application.

It is said that a new electric plant may be established in New Britain, Conn., shortly, as plans are being perfected to organize a company for the manufacture of electrical appliances. The proposed capital stock will be $100 000, and the proposed name will be the Improved Electrical Machine Co. Burton E. Baker, an electrician, is the originator.

In view of the increasing scope of usefulness for compressed air in machine and construction shops, the Clayton Air Compressor Works, Havemeyer Building, New York, have issued a special pamphlet of steam and belt actuated air compressors, air governors and air receivers of designs especially adapted to supplying air for this duty. This pamphlet will be sent to those interested upon application.

The citizens of Schenectady, N. Y., are rejoicing at the prospect of the early concentration there of the entire works of the General Electric Co., including those which have been at Lynn, Mass., and Cleveland, O., the latter under the name of the Brush Electric Co. It is stated that extensive additions will be made to the works at Schenectady and that a large number of additional men will be employed there, very considerable orders for street-car motors, etc., having been recently taken.

The Smith-Hobson-Brandt Co. are now open for business in Huntington, W. Va., in the mine, railway, steamboat and mill supply trade. The president is Randolph Brandt, N. Y.; vice-president, E. Howard Smith, who has for years been the leading traveling salesman for one of the largest supply houses in the South, and the treasurer and secretary is A. Maben Hobson, late superintendent of the Gauley Mountain Coal Co. They have several first-class agencies, amongst them being the New York Belting and Packing Co., on rubber goods, and J. B. Williams & Sons, Dover, N. H., on leather belting.

The Tradesman, of Chattanooga, Tenn., in its weekly review of the industrial situation in the South for the week ending May 14th, says: "The miners' strike has caused preparations to be made for shutting down another furnace, and a want of coal is reported in a few places. In other respects there is no change in the labor situation, and both parties are confident and determined. There is a decided improvement in the lumber industry as is shown by the number of new plants and of enlargements of existing ones reported for the week. Favorable weather has greatly improved the condition of the growing crops, and the farmers' prospects are now quite encouraging. In general business and in financial circles matters are quiet, with reports of less business than usual at this season, and a demand for money not equal to the supply. *The Tradesman* reports forty-nine new industries as incorporated or established during the week, together with eight enlargements of manufactories, and sixteen important new buildings.

Machinists' Supplies and Iron.

NEW YORK, May 19, 1894.

Iron—American Pig—We quote Standard Northern brands, No. 1 Foundry, $12.50 to $13.25; No. 2, $11.50 to $12.25; Gray Forge, $10.75 to $11.00. Southern brands are quoted at $11 50 to $12.25 for No. 1 Foundry; $10.50 to $11.00 for No. 2, and $10.00 to $10.25 for No. 3.

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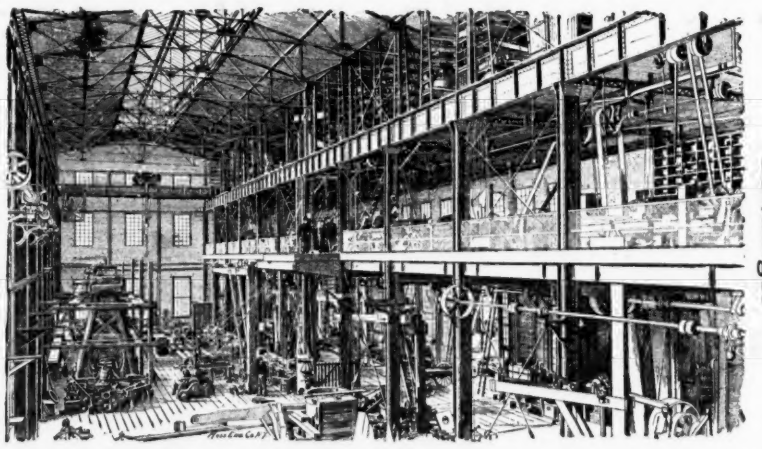

Iron and Steel Bridges and Buildings.

The above illustration is taken direct from a photograph, and shows the interior of a Machine Shop designed and built by us for The Dry Dock Engine Co., at Detroit, Mich. The central portion, or Erecting Room, is 40 feet wide, with a gallery three stories high on one side, this gallery being 27 feet in width. The upper floor of the gallery is used for storing patterns, while the second floor is used for light machine work and the lower floor for heavy machine work—this lower floor being controlled by jib cranes, which also swing out into the central portion, thus delivering material from the wings by the means of jib cranes and the traveling crane to any portion of the Erecting Room. The whole framework of the building is of Iron, with brick filling for the side walls.

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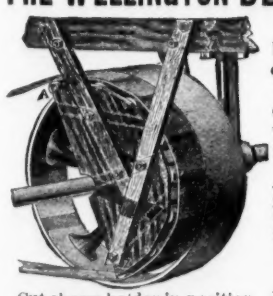

Large or small belts shifted from driving pulley and held at rest, and easily slipped back when machine is to be started.
It dispenses with loose pulleys, saves belts, and is perfectly safe.
It is *cheap*.
Write for descriptive circular and price list to
Cut shows holder in position beside driving pulley.
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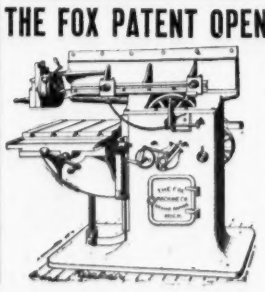

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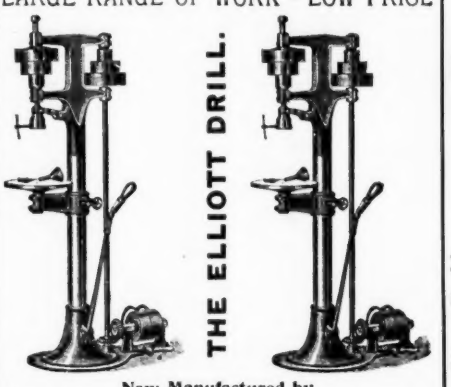

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9	1 3 8	.95
10	1 1-2	.95
11	1 3-4	1.10
12	2	1.20
13	2 1-4	1.35
14	2 1-2	1.45
15	3	1.60
16	3 1-2	1.80
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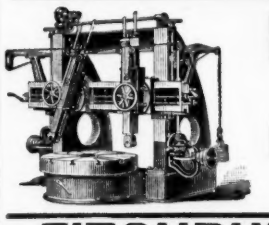

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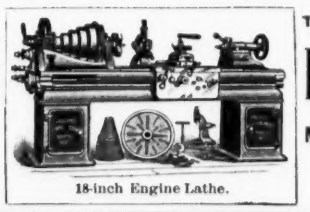
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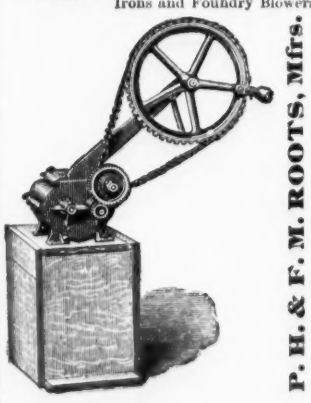

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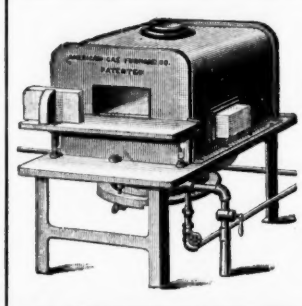

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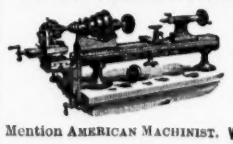

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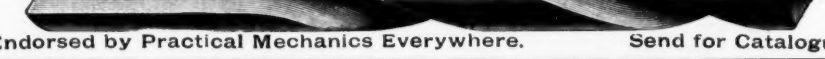

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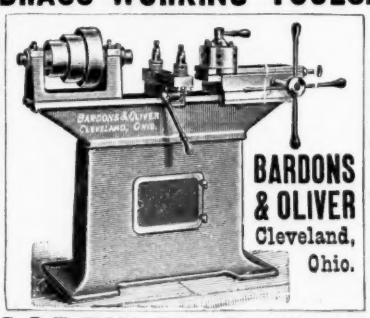

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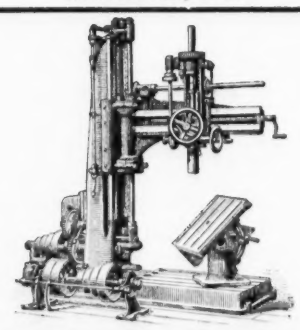

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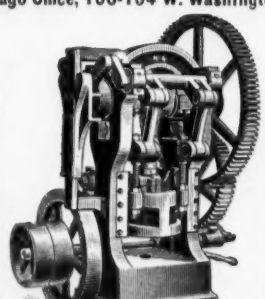

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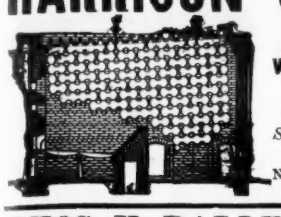

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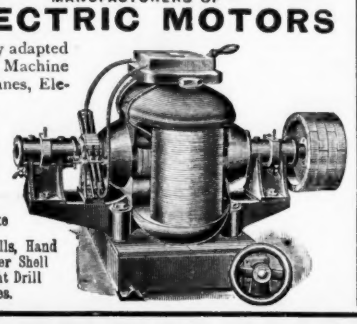

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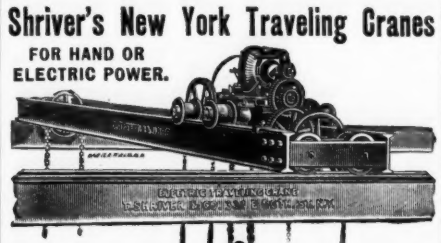

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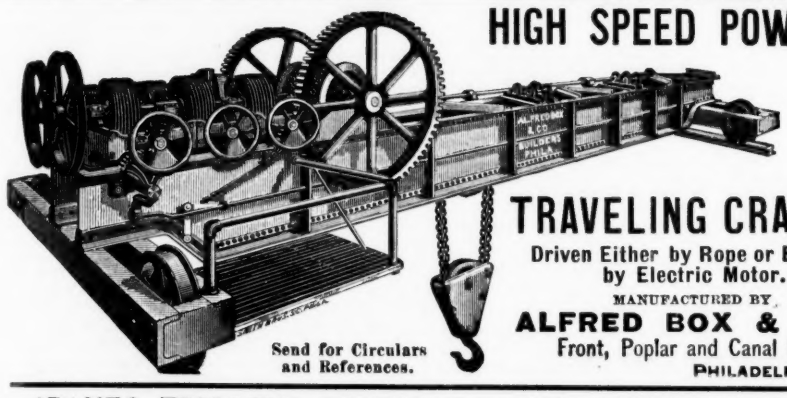

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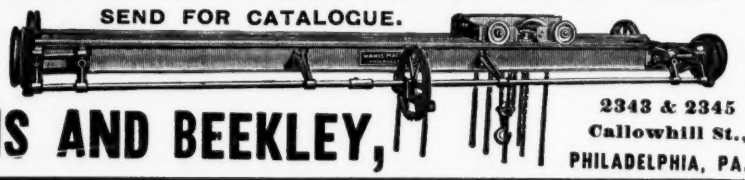

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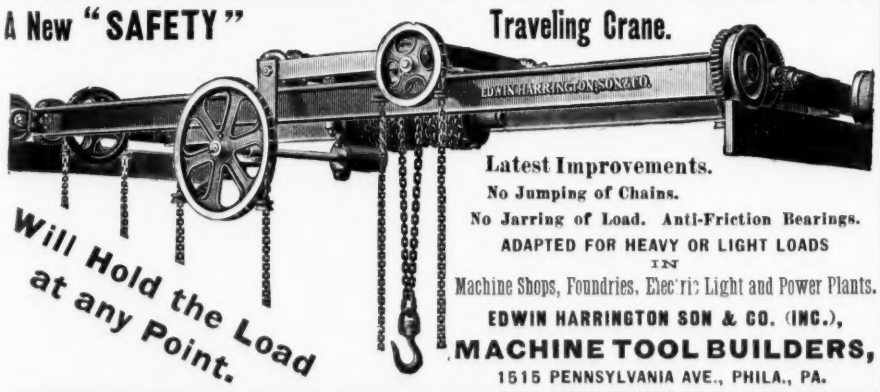

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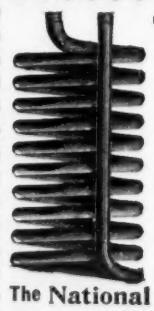

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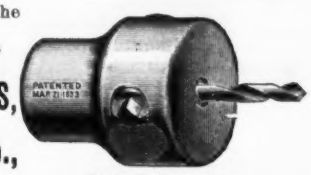

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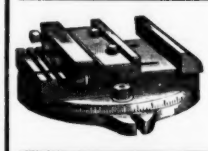

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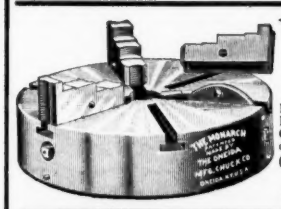

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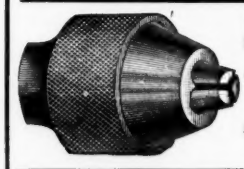

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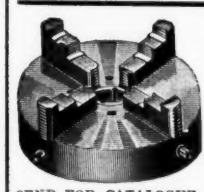

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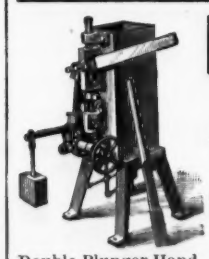

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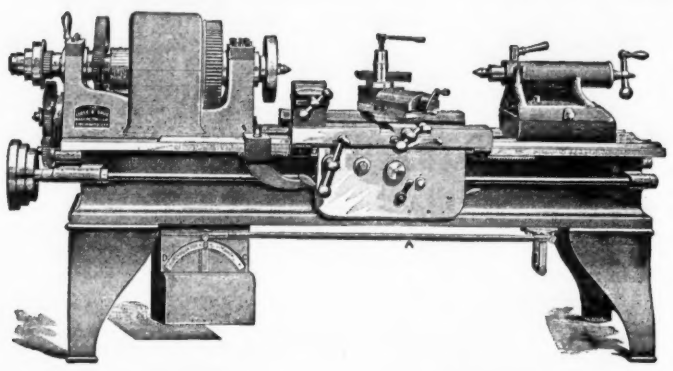

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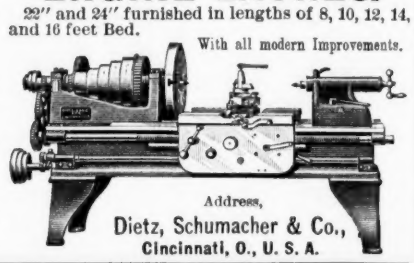

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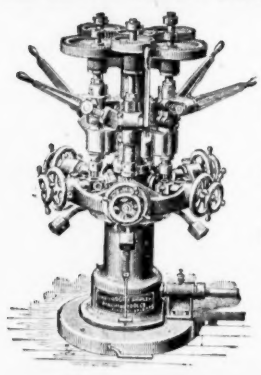

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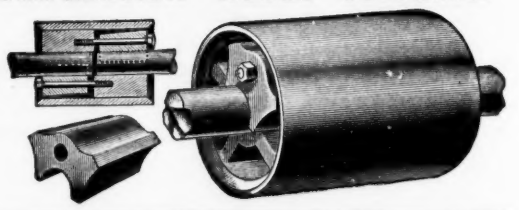

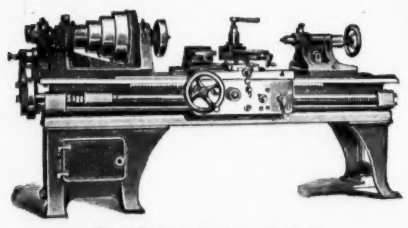

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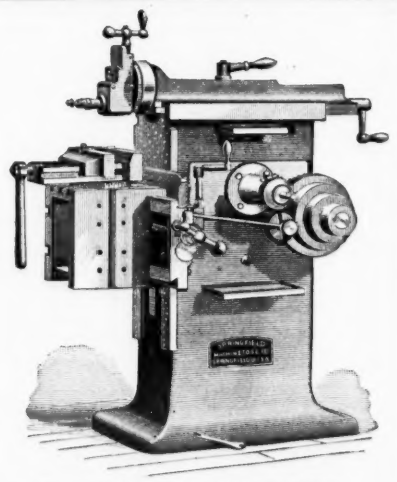

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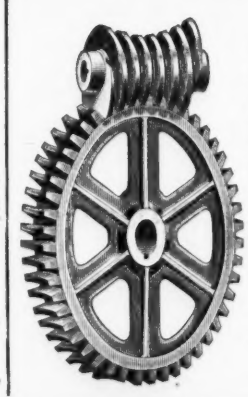

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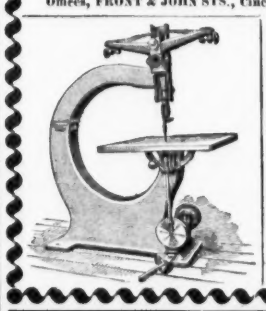

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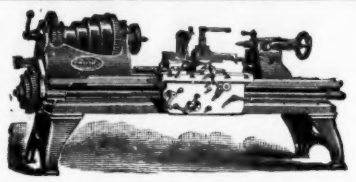

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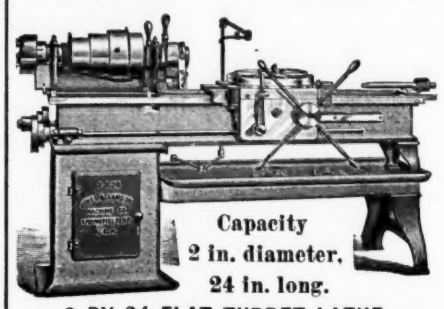

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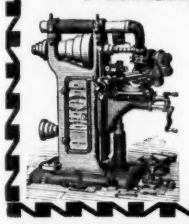

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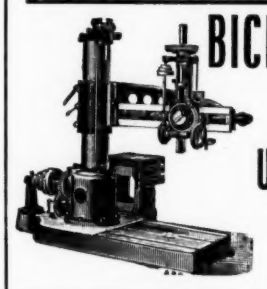

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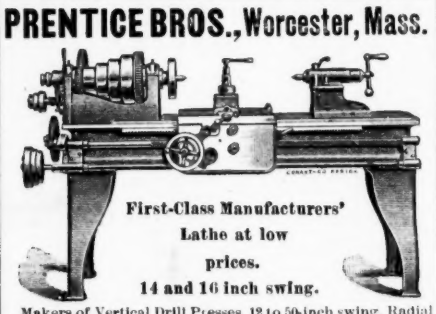

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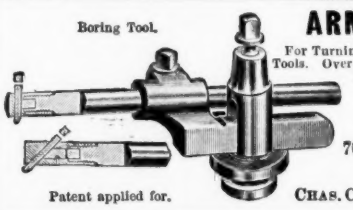
SCHUCHARDT & SCHUTTE, 59–61 Spandauerstrasse, Berlin, Germany.
ADPHE JANSSENS, 16 Place de la Republique, Paris, France.

Boring Tool.



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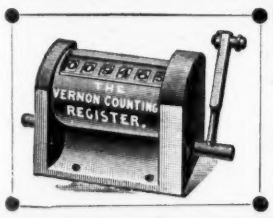

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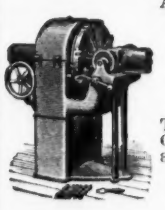

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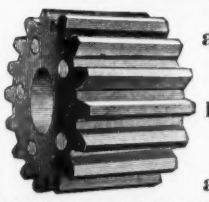

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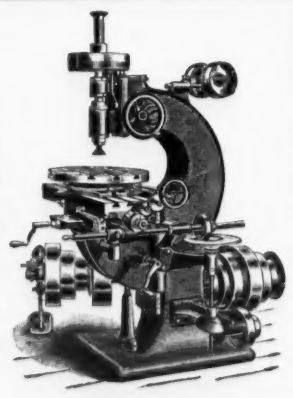

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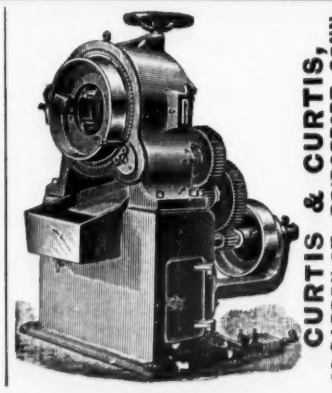

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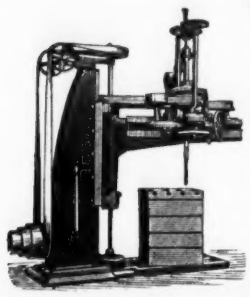

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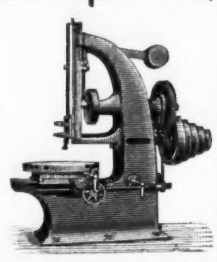

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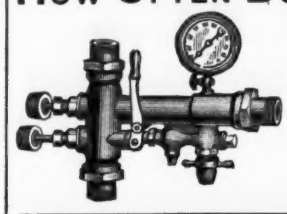

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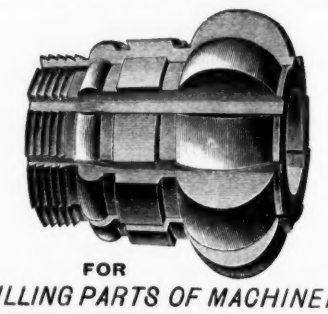

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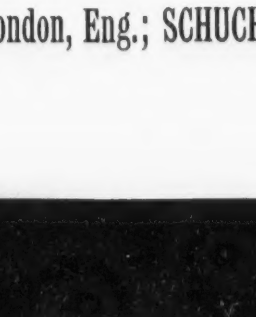

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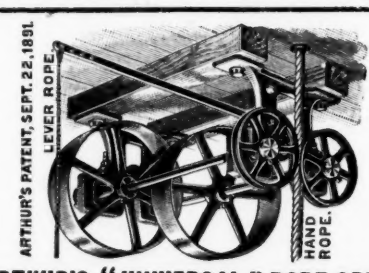

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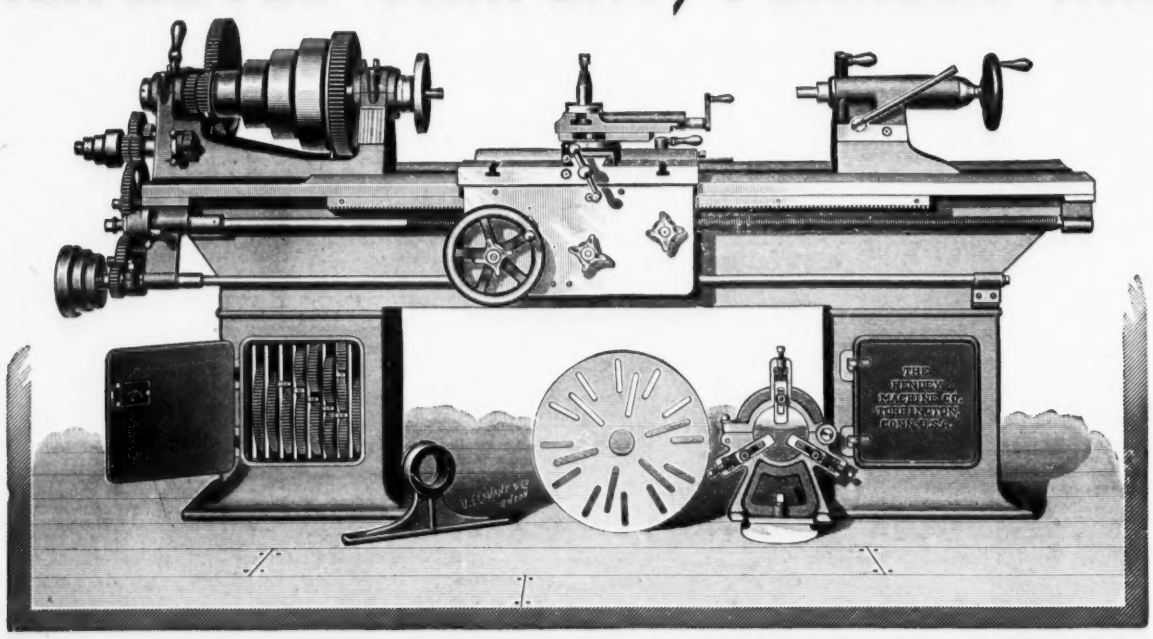

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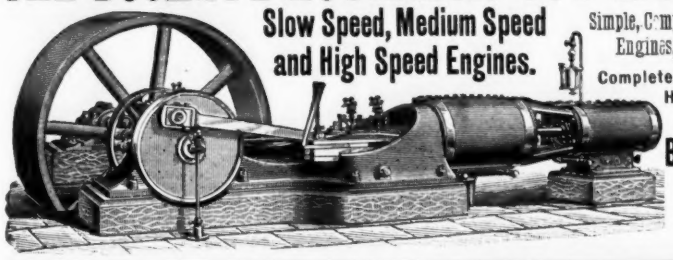

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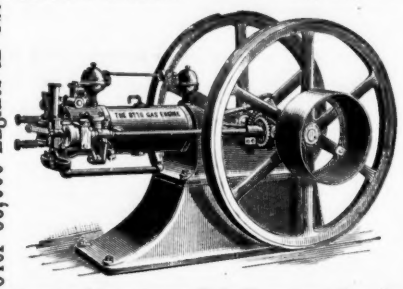

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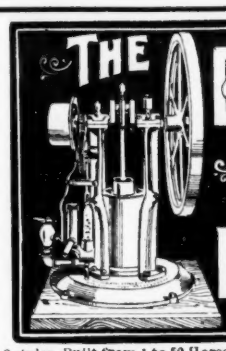

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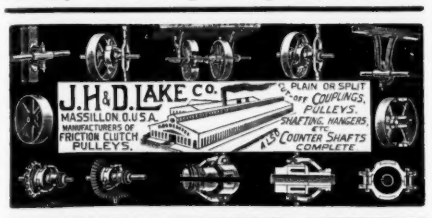

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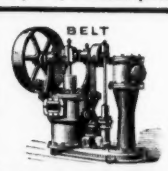

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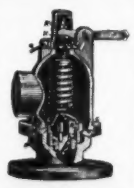

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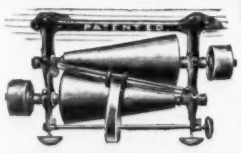

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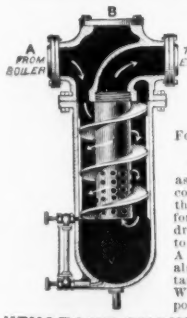

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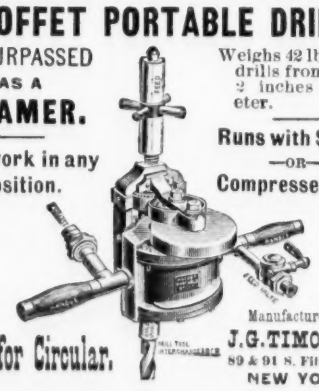

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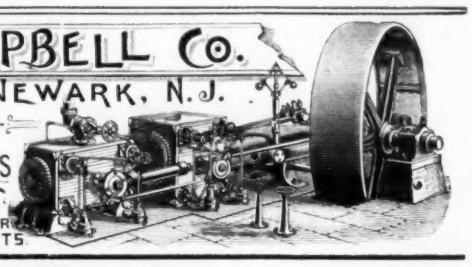

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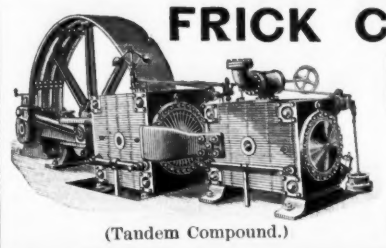

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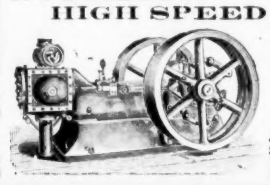

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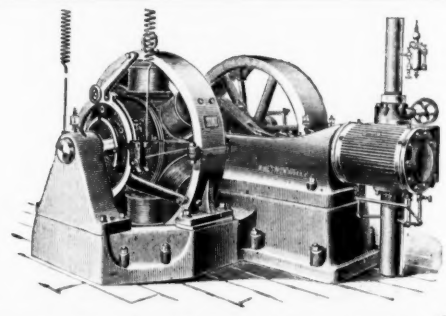

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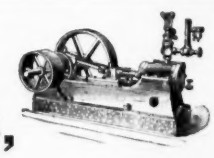

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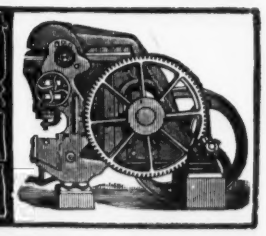

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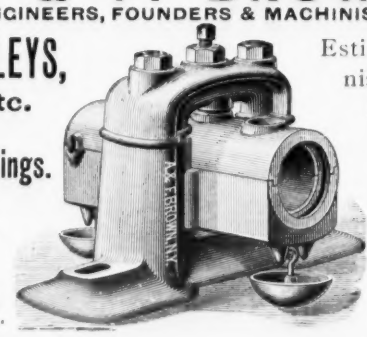

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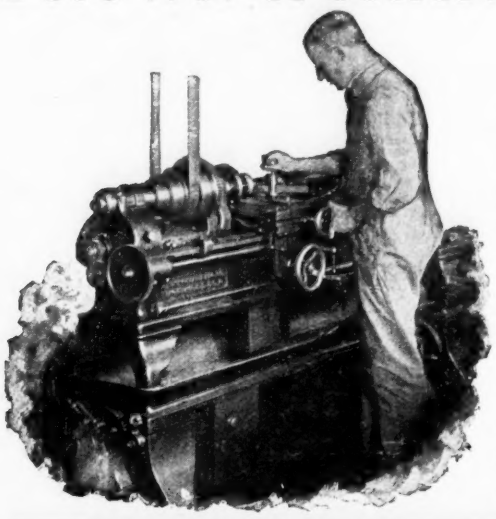

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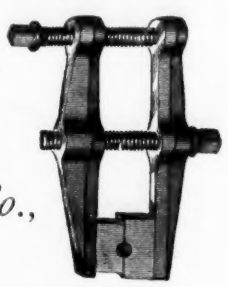

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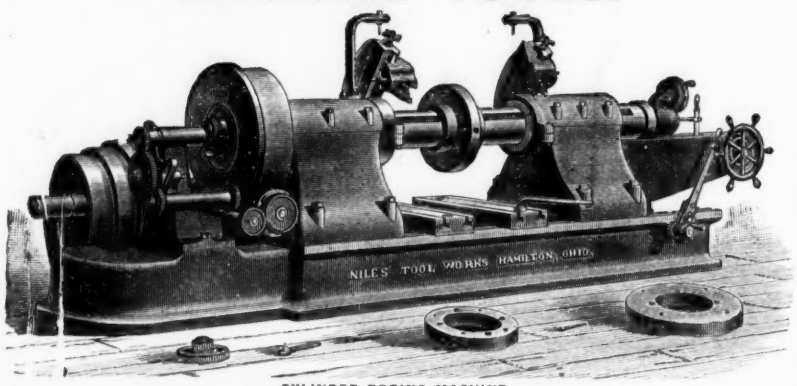

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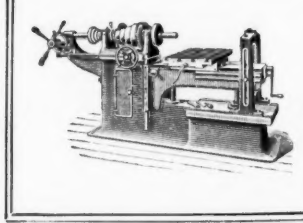

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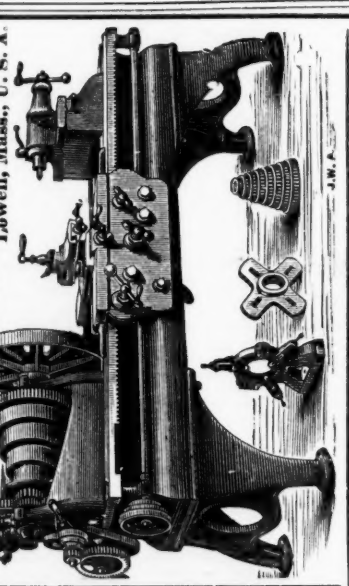

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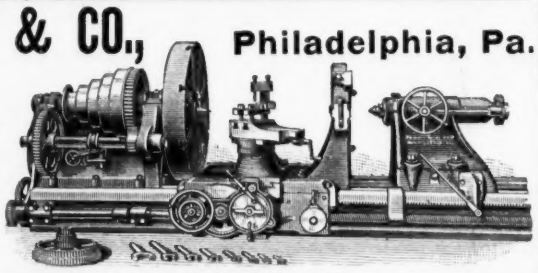

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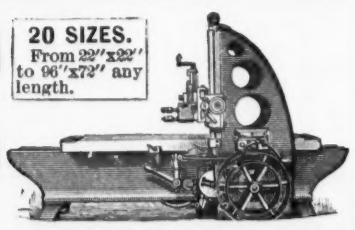

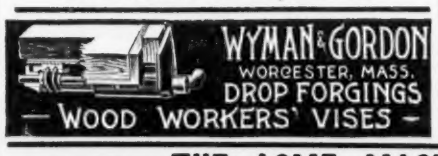

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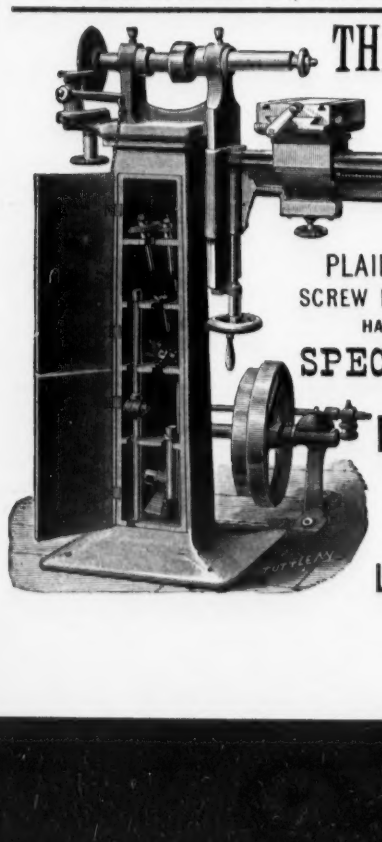

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